["TEXTS AND NOTES ON MEDIA ARCHAEOLOGY"]

I MEDIA ARCHAEOLOGY AS SCIENCE / OPERATIVE MEDIA ARCHAEOLOGY (nearly edited)

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I MEDIA ARCHAEOLOGY AS SCIENCE / OPERATIVE MEDIA ARCHAEOLOGY (nearly edited):

HANDS ON / OFF. (RE-)ENACTING TECHNOLOGY

Performative diagrammatics

Media Archaeological "labs" nowadays invite to tinker with technical, especially electronic devices, analog or digital. Even if the haptic experience of media materiality is vital in times of so called immaterial information flows and virtual reality, it does not suffice, though.[1] Touching an old cinema projector does not reveals the mechanism of its resulting in moving images; it need running the mechanism as process, as "temporal object" (*Zeitobjekt*, in Edmund Husserl's

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1   See Giovanna Fossati / Annie van den Oever (eds.), Exposing the Film Apparatus. The Film Archive as Research Lab, Amsterdam (Amsterdam University Press) 2016

sense). This is not haptic dilettantism and regressive "time to play" only, but driven and framed by epistemologic curiosity at the same time, for which Erkki Huhtamo coined the expression "thinkering" - kind of diagrammatic analysis of technical artefacts. Touching the material media archive is more than simply technological resensitation, especially for computing devices where the driving essence, the source code ("software") can not by haptically experienced at all.

"German" media studies is well known now as "materialist approach" or even "technological determinism". Among Friedrich Kittler's papers which are now at the National Archive of Literature in Marbach in Germany there is a quite material text: five electronic devices, the modular Moog-type synthesizer he contructed in the early 80s. An academic workshop has discussed how to cope with such a new type of "texts" which consists of circuit diagrams and solded electronics. Apparently Kittler did not construct this in order to generate electronic music himself but he saw tinkering as a method of analyzing and understanding electronic media. Of course it takes Media Archaeology to open these boxes for close diagrammatic reading. This has nothing to do with archaeological metaphors but rather with technical analysis of what we call media. This corresponds with the contemporary Retro Computing Scene which does not simply emulate old computer games on new platforms but actually opens the black box of ancient computers for close analysis of their micro-temporal hardware behavious which once constituted all the computer game aesthetics. In the moments of technical analysis, humans themselves become channels and processors of both machinic and mathematical logics.

The hands-on-media approach and the manual relation to technologies from a media-archaeological does not necessarily result in an anthropocentric perspective. The focus of media-archaeological analysis is rather on technical media where the "digital" oscillates between the discretization of manual input (fingers) and the processing of numerical values.

The distancing of man from the physical world by the intervention of technical machines, apparatuses and automata, in cybernetic epistemology, is not necessarily a threat to humanism but has been experienced as a liberation of man from its overall subjectivity as well. Once human hands are on technical instruments for input or control, a servo-motoric coupling takes place - replacing the strong human agency by subjecting and submerging it to feedback circuits. The notion of hand-based instrument control literally extends to time-axis-*manipulation*.

The phenomenological notion of "hands on instruments" needs to be rephrased in the language of engineering, of telegraphy, of typewriting and of digital computing. Traditional machinic typewriting does not ask for the hand as such any more; it radically differentiates the hands into ten discrete fingers. Finally the binary code reduces even decimal fingers to just two. What still looks like a playful *performative* handicraft, in reality is already a techno-mathematical *operation*. Even the painterly stroke dissolves into pixels. With "digitality" (no metaphor here), the human hand is radically mathematized.

The cybernetic coupling of human hands to the apparatus does not only refer to communication of man to machine in the present but the manual re-

enactment of machines from the past results in a tempor(e)ality which is different from the familiar historical discourse. Once human senses are coupled with a technological (especially sonic) setting, man is within its autopoietic temporal field, a chrono-regime of its own dynamics (or mathematics, when data are registered digitally). Such couplings create ecstatic moments of time: Man is instantaneously taken out of the hand-made cultural world (which is Giambattista Vico's definition of "history") and confronts the naked technological *dispositif*. There is no "historical gap" inbeween as known from other aspects of cultural history - no historicism at the moment when hands are on past media.

Media archaeology and cybernetics: Beyond anthropocentrism in the "hands on" approach

Sir Winston Churchill had not been able to attend the offical opening of the university college with was meant as an eternal memorial to his name in Cambridge, in 1964. Instead he wrote a signed letter (typescript) accentuating the need of Great Britain to train "technologists". This is not to be confused with practical *engineering* or *technicians* but accentuates the *logos* of *techné*.

The author of the mathematical theory which is still the basis for digital communication engineering today, Claude Shannon, once built a toy consisting of a box with a switch. If you switch "on", a hand came out and automatically switched "off".[2] In that sense, this paper deals with the ambivalences of the "hands on media" approach and the manual relation to technologies. Hands progressively seem to get *off* instruments by automation. From the anthropological view, however, the hand-as-tool has always already had a transient status between the internal and the external: It has been both the central definition and already an extension of man.

The distancing of man from the physical world by the intervention of technical machines, apparatuses and automata, from the perspective of cybernetic epistemology (which equally considers animal and machine as communicative systems[3]) is not necessarily a threat to humanism but has been experienced as a liberation of man from its overall subjectivity as well. Tn the introduction to his 1844 publication *The Pencil of Nature* Henry Fox Talbot explicitely remarks that the photographic illustrations "have been formed or depicted by optical and chemical means alone, and without the aid of any one acquainted with the art of drawing"; the objects are thereby not restricted to the idiosyncratic manipulations which accompany its representation when drawn by hand, "and considered only in its ultimate nature"[4]. Walter Benjamin in 1936 explicitely

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2 On "Shannon's toys", see Axel Roch, Claude E. Shannon. Spielzeug, Leben und die geheime Geschichte seiner Theorie der Information, Berlin (gegenstalt Verlag) 2009

3 The classic reference is still Norbert Wiener, Cybernetics or control and communication in the animal and the machine, Cambridge, Mass. (M.I.T. Press) 1948

4 Henry Fox Talbot, The Pencil of Nature [London 1844]; quoted here after the reprint New York (DaCapo Press) 1969, "Introduction" (no page)

compared the surgeon rather with the cameraman than with the painter's hand[5] - as it had been expressed by Dziga Vertov's film *Man with a Camera* indeed. As long as the endoscope in medicine was a hand-driven camera inspection of the human body, it interlaces both practices of imaging: painting and optical media. Media archaeology adopts this "cold" gaze which is analytical rather than hermeneutical.

Once human hands are on technical instruments for input or control, a servomotoric coupling takes place - replacing the strong human agency by subjecting and submerging it to feedback circuits. That moment, man turns into a cyborg, a true cybernetic organism and becomes part of a closed circuit (German *Regelkreis*) in terms of systems theory, becoming nothing more or less than one (analog) element within a system circuitry. In any cybernetic man-machine configuration, hands do not subjectively direct and control any more, but become an integrated part of a system. The moment a human hand is on the radio tuning knob for getting reception resonance, man himself gets "tuned" to the tempor(e)alities of the technical medium. Thereby the human subject culminates in technology itself.

While transitive hand-machine relations might be subsumed under the field of studies called "cultural techniques"[6] and remains somewhat anthropocentric, media archaeology with its focus on nondiscursive human-machine constellations keeps a more ascetic distance to the human agency in favor of the technomathematical agencies themselves. For the purposes of such an analysis, the socio-cultural discourses that envelop technological processes must be momentarily suspended. Let us therefore rephrase the phenomenological notion of "hands on instruments" in the language of engineering. This even allows for a direct short-circuit between media-archaeological analysis and prehistoric archaeology. Not by coincidence it has been a palaeontologist who described the evolutionary externalisation of human memory into storage technologies.[7] The same is true for the haptic agency of the human hands.

a) Type-writing and digitality

Telegraphic handicraft, "manipulation" and technology

In the German dictionary *Brockhaus' Konversations-Lexikon* from 1894, the entry "Manipulation" is defined as artful handling, which extends as well to an almost techno-logical operation. A few years later, the rival dictionary *Meyers Großes Konversationslexikon* from 1908 adds the "Manipulator", defined as telegraphic input device (German *Taster*). The Morse Code does not only include the electroacoustic dot and dash, but as well the temporal space

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5 See Walter Benjamin, The Work of Art in the Age of Mechanical Reproduction [1936], in: same author, Illuminations, London 1973, 238
6 See Theory, Culture & Society, vol. 30, no. 6 (November 2013), Special Issue *Cultural Techniques*, edited by Jussi Parikka / Geoffrey Winthrop-Young
7 André Leroi-Gourhan, La geste et la parole, vol. I: Techniques et langage, Paris 1964; vol. II: La mémoire et les rythmes, Paris 1965, Paris (Albin Michel)

inbetween, the pause (reminiscent of the so-called "silent piano", a special instrument for practicing keyboard playing without disturbing the surrounding area). All of the sudden, the haptic (as emphasized by McLuhan) extends to the microtemporal gap. But the hardware telegraph lines which were built to facilitate telecommunication suffered from heavy signal degeneration across space. When the signal became too weak, it had manually to be notated for new input; therefore a telegram sent between London and Kalkutta was frequently subject to improper transmission by personel with deficient language facilities. The solution was their replacement by nonhuman repeater-regenerators: the electro-magnetic (later vacuum-tube based) relay. Today, the binary codes allows to "write" by reducing the alphabet to only two symbols which can be operated by a simple movement of the hand: switching relays *on* and *off*.

Type-writing: The de-coupled relation of the hand to writing

Traditional machinic typewriting does not ask for the undifferentiated hand any more; it radically separates the hands into ten discrete fingers. Finally the binary coding machine reduces even decimal fingers to just two.

Inbetween has been a very popular alternative to the ten finger-operated keyboard, the typewriter trade mark Mignon which at the beginning of 20th century was popular in Europe. Here we find the alphanumeric input system reduced to a mouse-like pointer which is activated in the "binary" mode with just two keys for affirmation and for spacing.

The "digital" is not about hands, but fingers - even if Jeron Lanier in 1989 presented a data glove as an interface for navigating within virtual space; immersion here happens by an extended data *manipulation*. What still looks like a playful performative handicraft, in reality is already a techno-mathematical operation. While my fingers hack such thoughts in symbolical code on the keyboard of my laptop, the media-archaeological distance is aware that most writing is done within the microprocessors themselves where algorithms reign. Different from a typewriting machine which is still an instrument, the computer has already become what Gotthard Günther once called the "transclassical machine".[8]

According to Alan Turing's paper "On Computable Numbers" written at Cambridge in 1936, all operations of a calculating machine can be performed manually as long as man is equipped with squared paper, a pencil and a rubber gum. But at that moment, man is not authoring the process in terms of traditional literary writing, but himself is both servomechanically and mentally subjected to a sequence of discrete state, therefore becoming a "paper machine". The computer is transmanual - even though most users still experience and interface this machine by symbolic input *via alphanumeric* keyboards. Even the manual opening of the black box called personal computer does not lead to a more haptic and intuitive understanding of its algorithmic

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8 See Gotthard Günther, Das Bewußtsein der Maschinen. Eine
   Metaphysik der Kybernetik, Krefeld / Baden-Baden (Agis), 2nd ed.
   1963, esp. supplement IV (Die "zweite" Maschine), 179-203

machinery. If one researches the inner side of a computer, one gets stuck with the circuitry and internal microchips. The computer becomes intangible.[9]

A manuscript once literally meant the handwritten unique document. With a law dating back to 1997 in Germany, the digital signature became legally equal to handwritten signature. Handwriting radically differs from machinic typewriting. Handwriting has been a common term for both the concrete individual writing (graphology) and more general for an individual style. This gap closes when etymologically referring back to the material instrument, Latin *stilus* which both inscribed and erased symbols on wax tablets. With the hand on the *stilus* to notate ideas in the alphabetic code, man already becomes a symbol-processing machine in the scriptural moment, but only the printing press inaugurated an epistemology of abstract combinatorics resulting in the mathematisation of writing.

Even the Gutenberg Bible emulates the look of handwriting by using types which express kalligraphic Gothic texture[10] and therefore dissimulates the technicality of identically reproducable letters - just as the letters on a computer screen dissolve into bit-mapped graphics when looked at "from behind".

In a deep epistemological sense, the writing and reading of discrete alphabetic letters preconditioned scientific analysis which literally is an elementary practice - different from "acoustic space" which (according to McLuhan) returned with electronic communication media. For the age of electricity, McLuhan identifies a return of the primordial (oral language-based) "tacility" in terms of the temporal moment with its decisive criterium being its (almost) instantaneous speed of transmission.[11]

Techné and keyboard

Martin Heidegger differentiates ancient Greek *techné* as handycraft (German "Handwerk") from machine technique.[12] As opposed to the energetically hand-driven hammer as tool, a technology is a mode of control. In that sense, the hammer becomes a technological device only when it is included in a hammer piano - intermediated by fingers on the keyboard. The media philosopher Vilém Flusser interpreted the Baroque *toccata* as musical touch, the literal fingertip

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9 See Rainer C. Becker, Black Box Computer. Zur Wissensgeschichte einer universellen kybernetischen Maschine, Bielefeld (transcript) 2012, 12f

10 See Sonja Neef, Abdruck und Spur. Handschrift im Zeitalter ihrer technischen Reproduzierbarkeit, Berlin (Kulturverlag Kadmos) 2008, 91

11 See Till A. Heilmann, Digitalität als Taktilität. McLuhan, der Computer und die Taste, in: Zeitschrift für Medienwissenschaft 3, no. 2 (2010), 125-134 (128)

12 See Martin Heidegger, Leitgedanken zur Entstehung der Metaphysik, der neuzeitlichen Wissenschaft und der modernen Technik, Frankfurt/M. (Vittorio Klostermann) 2009, 301

on the keyboard (with its German expression *Tastatur*).[13] One special key-stroke instrument in the collection of the Musikinstrumentenmuseum Berlin is the *Liebmanista*, manufactured for a piano player who had lost most of his fingers in World War One. By pressing single keys it allowed for playing whole accords; this is a reduction of the hand to code. The transformation of the "digital" keyboard operated by decimal fingers to the binary sense of computing took place with the *Synclavier II*, an electronic piano as digital synthesizer.[14] All of the sudden, the keyboard as coupling between fingers and mechanism, even if it is still perceived as "instrumental", becomes a sublime cybernetic coupling between human and machine.

Digitality instead of the whole "hand": fingers and numbers

Hands on instruments in the engineering sense means *soldering* as analog technique; this is opposed to typewriting and programming in the digital code. Doing things symbolically (machine notation) differs from wiring and patching electronics manually close to the "real" of hardware.

The traditional counting device *abacus* always operated on discretisation. Numerical computing differentiates the hand into fingers, performing "analysis" (elementarization) with which - different from geometrical drawing - symbolic notation (alphabetical and numerical mathematics) corresponds. In chapter 11 of *Understanding Media* McLuhan defines the nature of the number as "an extension and separation of our most intimate and interrelating acticity, our sense of touch"[15]. A media-archaeology of the digital detects the correlation between discrete arithmetic calculation and touch indeed. Tactility in digital mathematical machines is different from the discrete fingertip operations of the symbolic machine called typewriter. Counting in times of mechanized mathematics takes another dimension which is algorithmics.

There is a tight coupling between the digital and number *manipulation*. The classic gesture of telephoning culminated in dialling with 10 numbers being addressed manually by the index finger (Latin *digitus*). But he meaning of the digital in current media culture rather refers to computer-based technologies. More precisely, the real message of the digital is the binary code - which in fact reduces the hands with 10 fingers to just two micromovements of on/off gestures.

The "human" hand has always been a mechanism as an interface in the technical sense. The uncanny of the hand is its function in the autonomous brain-hand-system in the cybernetic sense. Faced with robotic and other prosthetic "hands", humans are not sure any more if this is an integral human

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13 See Rainer Guldin, "To make music with visionary power": On the Relationship of Music and Mathematics In Vilém Flusser's Work, in: Flusser Studies 17 - Music and Sound in Vilém Flusser's work; *online* http://www.flusserstudies.net/current-issue (May 2014)
14 Operated by a *n.e.d.* computer ("new england digital" company) with a VT 100 graphics monitor.
15 McLuhan 1964: 107

body part, its extension or alienation. The discretization of the human hand into single fingers as a function of cultural evolution culminates in character writing. This technically corresponds to digital sampling as the central momentum in the conversion of analog signals from the physical world into numerical computing. Its German equivalent is a very manual term indeed: "abtasten".

Between manual and digital painting

According to McLuhan, "the stipple of points of Seurat is close to the present technique of sending pictures by telegraph, and close to the form of the TV image or mosaic made by the scanning finger" of the cathode ray tube. "All of these anticipate later electric forms because, like the digital computer with its mulitple yes-no dots and dashes, they caress the contour of every kind of being by the multiple touches of these points. Electricity offers a means of getting in touch with every facet of being at once, like the brain itself. Electricity is [...] primarily tactile."[16] Even if McLuhan obviously confuses digital pixels with random distribution of chemical picture elements in photography and the painterly stroke in *pointillisme*, he is right in terms of the electric impulse.

Already "[...] photography made people realize that art was not necessarily the manipulation of a plastic substance like paint or materials of any kind. It is an act of selection, you press the shutter."[17] Only with computer-based imagery, in a kind of unexpected recursion, the artistic hand comes back to manual picturing, but not in a painterly mode any more: "The artist no longer directly touches or manipulates color, material, or objects. He or she manipulated algorithms, which are more or less abstract"[18] - which indeed requires an education beyond the traditional Art Academy. The binary code of digital signal processing results in a radical mathematization even of the painterly hand. But maybe traditional painting here proudly resists, all the more, gaining pride and strengh from the *retro-effect* of manual easel painting *versus* the type-writing act of algorithmic imaging and programmed computer graphics.

b) Hands on the artifactual past

Re-enacting the past

Different from the discursive tendency to think history and time in terms of narrative, let us focus on truly media-generated temporalities in machine-specific terms. Such a media archaeology leads to a kind of epistemological reverse engineering. In a way unlike frozen museum displays, one can

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16 McLuhan 1964: 247 f.
17 Jonathan Benthall, The Computer as Medium, in: Margit Rosen (ed.), A Little-Known Story about a Movement, a Magazine, and the Computer's Arrival in Arts. New Tendencies and Bit International, 1961-1973, Karlsruhe (ZKM) / Cambridge, Mass. (MIT) 2011, 461-465 (461)
18 Abraham A. Moles, Introduction to the Colloquy [sc. *Computers and Visual Research*, Center for Culture and Information, August 3-4, 1968, Zagreb], reproduced in: Rosen (ed.) 2011: 263-266 (265)

experience the media-cultural past by literally getting "in touch" with the artefacts. At Humbolt University's Media Archaeological Fund, a configuration of apparently "dead historical" media devices can be operationalized through playful tinkering.[19] In this sense the question of media dynamics and agency is taken seriously.

The interpretation of media is nothing without doing; a technical artifact discloses its essence only when operating. According to Martin Heidegger, everyday things are either *zuhanden* (ready-to-hand) or *vorhanden* (present-to-hand).[20]

Manual experimentation of time with machines

"Operativity" is essential for the definition of technical media. If the cultural and discursive knowledge of technology is not limited to illustrations in texts and books, to distant observation in museums and to pure documentation in archives, there is a need for platforms where technical objects can be operated "hands on" in their primary materiality. Whenever we lay hands on an ancient tool, we share at least a bit of that past knowledge that is actually not past when it mechanically reacts - a sort of "re-presencing".[21] Media come into being only as "temporal objects" (*Zeitobjekte* in Edmund Husserl's phenomenology).[22]

The best method to understand a medium is by its re-engineering and its functional re-enactment. Charles Sanders Peirce describes diagrammatic reasoning as such: "Similar experiments performed upon any diagram constructed to the same precept would have the same result."[23] - just as we share Pythagoras' sono-mathematical experience by operating the monochord with our hands today. Collingwood equally reminds of the endurance of Pythagoras' geometric discovery concerning the square on the hypotenuse. It is just that the present mind must be somewhat *tuned* in the right cognitive mood.[24] We are certainly not in the same historical, that is: contextual situation

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19 See `http://www.medientheorien.hu-berlin.de/fundus`; operational videos can be activated under the URL
`http://www.youtube.com/user/HUMediaStudies`
20 See Martin Heidegger, Sein und Zeit [1927], Tübingen 1993, 69
21 See Vivian Sobchak, Afterword: Media Archaeology and Re-presencing the Past, in: Media Archaeology: Approaches, Applications, and Implications (Berkeley: University of California Press, 2011), 323-33
22 "Unter *Zeitobjekten* im *speziellen Sinn* verstehen wir Objekte, die nicht nur Einheiten in der Zeit, sondern die Zeitextension auch in sich enthalten": Edmund Husserl, Die Vorlesungen über das innere Zeitbewußtsein aus dem Jahre 1905, in: ders., Zur Phänomenologie des inneren Zeitbewußtseins (1893-1917), Den Haag 1966, 3-98 (23); see Edmund Husserl, On the phenomenology of the conciousness of internal time (1893-1917), transl. John Barnett Brough, Dordrecht (Kluwer Academic Publishers) 1991, 24
23 Charles Sanders Peirce, Collected Papers, vol. II: Elements of Logic, Cambridge, Mass. (Harvard UP) 1932, 350
24 R. G. Collingwood, The Idea of History [*1946], rev. ed. Oxford et al. (Oxford University Press) 1993, 217 f.

like Pythagoras, since the ways of listening and the psycho-physical tuning are different. But with our haptic organs (ears and fingers) "on" the monochord, we experience a time-machine in a different sense: It lets us co-originally participate at the discovery of musicolgical knowledge.

In the Italian *renaissance* of knowledge from antiquity, Vincenzo Galilei performed a number of experiments to investigate the nature of musical harmonics[25] as a kind of media-based archaeology of the acoustic, employing the lute not as a musical instrument but as a piece of laboratory equipment. Once human hands are involved with experimentation time, the past can be re-enacted. On the diagrammatical level, the re-enactment is time-invariant; on the operative level of implementation, the materiality of the medium itself - even if it imposes certain vetoes due to the historicity of the instrument - the epistmological operation remains intact *in principle* (*archaeo*logically). When a researcher set out to replicate Galilei's experiment using a lute built in the 17th century, the present condition of the instrument required the use of some substitutions for the materials originally used by Galilei in his experiment; "however, these did not affect the basis tenets of the experiment"[26]. In the processual event of the reenacted experiment one shares the same temporal field. Hermann von Helmholtz was sceptical about the possibilities to truly re-enact a musical experience in the past; we are dependent on historical information indeed.[27] But media-archaeological experimentation (simulation as opposed to historicism) allows for access to the invariant elements of knowledge in time indeed.[28]

But for computational media, the sound of the archive is not activated by manual re-play any more but by emulation without human intervention. The software simulator of the archaic British EDSAC electronic computer (designed for museological re-enactment) allows for an explicit "analogy between a computer program and a musical score - once described as 'frozen music' needing only an orchestra to melt it"[29].

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25 As described in: Vincenzo Galilei, A Special Discourse Converning the Unison, trans. in Claude V. Palisca, The Florentine Camerata. Documentary Studies and Translations, New Haven / London (Yale University Press) 1988, 203-205

26 Claude V. Palisca, Was Galileo's Father an Experimental Scientist?, in: Paolo Gozza (ed.), Number to Sound. The musical way to the scientific revolution, Dordrecht / Boston / London (Kluwer) 2000, 191-199 (195)

27 Hermann von Helmholtz, Die Lehre von den Tonempfindungen als physiologische Grundlage für die Theorie der Musik, Braunschweig (Vieweg) 1863; reprint of the 6th edition (Braunschweig 1913): Hildesheim / Zürich / New York (Olms) 1983, 411

28 See Martin Carlé, Geschenke der Musen im Streit ihrer Gehörigkeit. Die antike Musiknotation als Medium und Scheideweg der abendländischen Wissenschaft, in: MusikTheorie. Zeitschrift für Musikwissenschaft, vol. 22, no. 4 / 2007, 295-316 (313f)

29 Martin Campbell-Kelly, Past into Present: The EDSAC Simulator, in: Raúl Rojas / Ulf Hashagen (eds.), The First Computers. History and Architecture, Cambridge, Mass./ London (MIT Press) 2000, 397-416 (399). The operations of this Electronic Delay Storage Automatic Calculator were themselves based on a set of

Symbolical re-enactment of machines: From YUGO back to Babbage

Different from signal storage media like photography and phonography, the type-written transmission of information from the past in the alphabetic code puts the receiver into a machine-like decoding mode which cuts short the "historic" temporal differance in favor of immediate communication. Therefore "[...] the historian may re-enact a past event if that event is itself a thought"[30]. The symbolically coded channel of tradition is to a hight degree time-invariant, thereby ahistoric.

"[...] one and the same act of thought may endure through a lapse of time and revive after a time when it has been in abeyance. Take a [...] case [...] where the interval covers the whole lapse of time from Euclid to myself. [...] Euclid and I are not (as it were) two different typewriters which, just because they are not the same typrewiter, can never perform the same act but only acts of the same kind. A mind is not a machine with various functions, but a complex of activities [...]. Granted that the same effect can happen twice in different contexts within the complex of my own activities, why should it not happen twice in two different complexes?"[31]

Symbolic operations can indeed be re-enacted against historical time which has passed inbetween. A "manual" (German *Handbuch*) for motor cars allows for enacting a machine even if it seems past. The manual[32] for the British edition of the ex-Yugoslavean YUGO car is not only readable as an instructive metatext but in going down to the minutest detail it is itself almost a paper machine. It allows to deconstruct and to reconstruct a Yugo from scratch. The visual algorithm of the manual is convincing: "The tasks are described and photographed in a step-by-step sequence so that even a novice can do the work"[33] - which is chronophotography in the best pre-cinematographic tradition of Marey and Muybridge. The cover has a jacket proudly comments: "Every Manual based on a complete Stripdown and rebuild".

Charles Babbage once invented his "mechanical notation" in order to avoid the time- and cost-consuming task of actually building a designed calculating machine by handicraft. The hand becomes a symbol-drawer instead of hand-writing. This reminds of Turing's argument developed in 1936: calculations performed by humans with symbols written and erased on paper turns man himself into a "paper machine".[34]

`acoustic` mercury delay lines – a serial access memory which enacted a cyclic, ultrasonic rhythm.

30 Collingwood's 1928 lecture "Outlines of a Philosophy of History", in: same author 1993: 443

31 Collingwood 1928/1993: 287f

32 YUGO / Zastava. Owners Workshop Manual, Somerset (Haynes Publishing Group), 2nd ed. 1990

33 YUGO / Zastava Manual, p. 5

34 See Alan Turing, On Computable Numbers, with an Application to the Entscheidungsproblem, in: Proceedings of the London Mathematical Society

While Franz von Reuleaux' symbolical notation accentuates the machinic modules, Babbage accentuates the temporal flow.[35] The mechanical notation would thereby allow to reproduce the procedural behaviour of the designed machine, as expressed in his so-called Timing Diagram (cycling units) and Flow Diagram which is well known today from flow charts in computer programming. By introducing time into the symbolic regime, the machine starts to operate. It was Babbage's mathematical companion Ada Lovelace who decoupled mechanic computing of mathematics from the subject-centered human hand: "The science of operations [...] is a science of itself, and has its own abstract truth and value, just as logic has its own peculiar truth and value, independently of the subjects to which we may apply its reasings and processes."[36]

Later in the 1930s, when logical reasoning was applied to switching systems to develop electromechanical calculators, Claude Shannon demonstrated that Boolean logic could be applied to the same types of problems for which Babbage had designed his mechanical notation.[37] Here we perceive technological time in a double-bind between media history and media archaeology: On the one hand, Babbage's Analytical Machine was not realized in 19th century due to mechanical, financial and epistemological restrictions; on the other hand, by means of his mechanical notation the machine can be be re-enacted today without loss. For Babbage's bicentennary, the Science Museum has (re-)built the Difference Engine indeed. There is no historical gap inbeween as known from other regions of cultural history - no historicism in "hands on past media".

Circuit bending

One media-archaeological method of operative analysis in media arts is "circuit bending", a creative short-circuiting of (low-currency) electronic devices in (rhetorically expressed) "catachretic" ways, very often used in the acoustic field to create new kinds of sound by means of a "jumper" cabel which connects two points in the circuit in a way not intended by the engineers.[38] Unearthing previously un-discovered sounds in electronic devices is a media archaeology of the implicit acoustic knowledge of an electronic medium. In a way, Lev Thermin did this when mis-using radio technology to create his T*heremin-vox* which is circuit-bending by interference of the body (hand gestures) into an electro-magnetically oscillating field.

In its computational equivalent ("hacking"), the manual "tinkering" of electronic circuitry is replaced by "algorithmic thinking".

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(2), vol. 42 (1937), 230-265

35 See Berz 2001: 181

36 James Essinger, A female genius: How Ada Lovelace, Lord Byron's daughter, started the computer age, London (Gibson Sqiuare) 2014, 173

37 Jeremy Norman, Describing the Logic and Operation of Machinery by means of Notation, *online* http://www.historyofinformation.com/expanded.php?id=3179

38 See, e. g., http://absurdity.biz, and the compilation CD *Noise and Toys* vol. 1 (2006)

[Media materialism and Circuit bending]

"Dead" media become "alive" in media archaeological investigation which does not refer exclussively to past artefacts but is dedicated to opening up technologies in the present, in a critical way: hardware hacking, software studies, and circuit bending.[39] Media archaeology is hence not simply about times past but also rather about microtemporal processes within technologies themselves - a differend kind of radical historicism.

Circuit bending is about short-circuiting of (low-currence) electronic devices in "catachretic" ways, in the field of sound to create nows kinds of sounds by means of a "jumper" cabel which connects two points in the circuit in a way not intended by the engineers; experimenting with mis-connecting results in interesting sounds, the result is being hard-wired[40], and the compilation CD *Noise and Toys* vol. 1 (2006); unearthing previously un-discovered sounds in electronic devices is a media archaeology of acoustic, of the "implicit knowledge" of an electronic medium; Lev Thermin's mis-using radio technology to create his T*heremin-vox* = circuit-bending by interference of the bodily gestures as cariable capacitor within the antenna circuit; finally, investigative media-artistic archaology provides for analog electronic circuitry which is capable of detecting, that is: sonically "unearthing", e. g., the presence of 13.56 MHz RFID tags used in plastic cards.[41]

What *mis*wiring is in Circuit bending of analog electronics, is *dys*coding in digital software where material wiring is replaced by symbolical programming. A case of symbolic Circuit beding is datamoshing *alias* glitch art. Datamoshing is the process of manipulating the data of compressed media files, especially video streams, in order to achieve visual or auditory effects in realtime, that is: while the file is decoded[42]; video example http://datamoshing.com; accessed 25 November, 2017

WHICH KIND OF PHILOSOPHY IN / FOR TIMES OF COMPUTATION? A rather radical media-archaeological comment

Rooting the "post-computational": radical media archaeology

While computation is a core media-theoretical concern and falls within the comptetence of media studies (as long as its self-understanding is close to technologies), philosophy as the mother of all academic reflection of science and matter is a rich tradition which media theory only humbly dares to address. The following thoughts, arguments and hypotheses therefore limits itself to the media-archaeological way of questioning philosophy "after" computation, in its double sense: the epistemological impact (or challenge) of computation on

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39 For such media artistic practices, see the Microresearch lab, Berlin
40 See http://absurdity.biz
41 http://shop.marcboon.com/snifferkit.pdf
42 See "How to datamosh videos", http://datamoshing.com; accessed 25 November, 2017

traditional philosophy in the archaeology of knowledge, and computation "after" ("in the sense of") philosophical reasoning. Computation is operational mathematics. As method of inquiry, media archaeology - rather than being a nostalgic metaphor for discovering obsolescent technologies - therefore has to be close to both mathematics and philosophy, literally "radical" both in its focus on the *arché*, the principles (rather than simply historicial "beginnings") of technological being-in-action.

The term "post-computational" alludes to an explosion, a square potential of computing (hypercomputation); its archaeological operation is finding its square root as the inverse operation of squaring "... where $\sqrt{}$ is called the radical sign or radix"[43]. This primordial operation does not imply something historically remote, but corresponds with Heidegger's philosophical concept that Being can only be understood through what is close in the con-temporal sense. Media archaeology does not "post" the age of digital computing but "poses" the philosophical question of computation; computing is rooted in the cultural techniques of mathematical reasoning itself, therefore it is always "pre"-computational (though there are object which become explicit knowledge only by algorithmic high-speed computation at all, such as fractals).

Analytic rigour in the sense of the square root symbol ($\sqrt{}$) in mathematics and "diagrammatic reasoning" (Charles S. Peirce) is closer to techno-logics than to narrative discourse. The escalation takes place in Peirce's first sketch of an electric circuit diagram for solving a logic problem; philosophical logic here turns non-human. In his letter dated 30 December 1886 to Marquand who had build a mechanical logical machine, Peirce draws the first known electric circuitry diagram for performing logical reasoning, biased by a battery: "I think electricity would be the best think to rely on [...] where the circuit may be open or closed. [...] This is like multiplication and addition in logic"[44] - and the Arithmetic and Logic Unit (ALU) in micro-processors *in nuce*; techno-mathematics and techno-logistics converge.

To what degree is the electronic computer mathematized electricity? A concrete realization of the universal digital machine (the Turing machine) does not necessarily depend on electricity. Therefore media scholar Thomas Nückel reintroduces the techno-mathematical term *mechanical procedure* - "a term borrowed from the logician and mathematician Kurt Gödel who claimed its equivalence to both the Turing machine and the concept of the algorithm - to point out that the digital should be grasped epistemologically, not merely as a phenomenon shaped by the use of electricity, but as an amalgam of both the mechanical (as Gödel's 'mechanical procedure' defines it) and the electric. In this sense the digital should be regarded at its fundamental technical level in opposition to the standpoint of McLuhan in Understanding Media as the mechanical in the electric."[45]

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43 https://en.wikipedia.org/wiki/Square_root; accessed 12 May 2017

44 Note by the editors to Charles S. Peirce, Logical Machines, in: The New Elements of Mathematics, vol. III/1: Mathematical Philosophy, The Hague / Paris (Mouton) / Atlantic Highlands, N. J. (Humanities Press) 1976, 625-632 (632)

45 Thomas Nückel, e-mail statement, May 2017. See p. 81 in his M. A. thesis: Berechenbarkeit als Sphäre digitaler Medien [Computability as the Sphere of

Radical media archaeology is not about nostalgia of dead media, but techno-mathematical reasoning. Its approach to the (mes-)alliance of computing and philosophy is explicitly anachronistic, uncovering implicit *liaisons* between mathematics, philosophical reasoning, and the machine. The only scientific discipline which does *not* not think is mathematics *alias* the algorithmic machine.[46] Therefore philosophy "after" computation does not address a post-computational world but the implicit interlacing of philosophy and computation. If "[t]he machine is not a thinking being, but simply an automaton"[47], then the human mind is machinic itself when "thinking" (answers Jacques Lacan[48]). Algorithms as tool of non-human philosophizing lead to "digital non-humanities".

"The essence of technique is nothing technical", Heidegger declared in his critique of the Cartesean world[49]; it is rather techno-mathematical. A colour, when measured and analyzed into its sinuoidal components (Fourier), disappears in the phenomenological sense[50], just like a sound wave from within an electro-acoustic oscillator, when sampled into a computer file, is not an acoustic phenomenon any more but becomes implicit sonicity. To Heidegger's unease, nature, by media-technological measuring and calculating devices, is seduced to reveal its mathematical essence[51]. Whereas Pythagoras once saw numbers as embedded nature (like Leibniz´ *deus calculans*), the computer literally numbers the world processually - closer to mathematical Fourier analysis of physical vibrational events (sound, heat, electro-magnetic fields) than to any metaphysical aesthetics.

Epistemology of computing dis-covers implicit techno-logical knowledge and creates sparks if insight (momentary illuminations) by making explicit (therefore theoretical language) the beauty of knowledge imbedded within

Digital Media], submitted Winter term 2016/17, Humboldt-University, Berlin, Insititute of Musicology and Media Studies (https://edoc.hu-berlin.de/handle/18452/19708), referring to: Marshall McLuhan, Understanding Media. The Extensions of Man. London/New York: Ark Paperbacks (1964), 349

46 "Die einzige Wissenschaft, die nicht nicht denkt, ist die Mathematik": Friedrich Kittler, Ästhetik und Mathematik, in: Karin Hirdina / Renate Reschke (eds.), Ästhetik. Aufgabe(n) einer Wissenschaftsdisziplin, Freiburg i. Br. (Rombach) 2004, 270

47 L. F. Manabrea, Sketch of the Analytical Engine invented by Charles Babbage [1842], transl. by Ada Lovelace, in: B. V. Bowden (ed.), Faster Than Thought. A Symposium on Digital Computing Machines, London (Pitman Publishing)1953; paperback edition 1971, 349

48 See Jacques Lacan, Psychoanalyse und Kybernetik oder Von der Natur der Sprache [*1955], in: ders., Das Seminar II. Das Ich in der Theorie Freuds und in der Technik der Psychoanalyse, Weinheim / Berlin 1991, 373-390

49 Martin Heidegger, Die Frage nach der Technik, in: same author, Reden und Aufsätze, 2. Aufl. Pfullingen (Neske) 1959, 13-44

50 Martin Heidegger, Der Ursprung des Kunstwerks, in: Holzwege, 4th ed., Frankfurt/M. 1963, 35 f.

51 "Die Natur wird daraufhin gestellt, sich in einer berechenbaren Gegenständlichkeit zu zeigen (Kant)." Heidegger 1962/1989: 17

machine eventality. Thereby, even the electric condenser (the venerable Leyden jar) becomes an "objet philosophique" (in Bachelard's sense).

Rethinking technology from within, and the concept of operative diagrammatic reasoning, differs from the traditional philosophical approach. Once phenomena are no longer "transcendent" but identified and grounded in technology close to the signal, visual (or auditive) appearances on human-computer interfaces are identified as what they are: computational functions.

The Turing machine operates within a sphere of computability which is different from the human mind-based "noosphere" in Teilhard de Chardin's, or the electromagnetic "acoustic space" in Marshall McLuhan sense), defining everything that could possibly be executed by digital machines, analyzing „the digital" on a fundamental level by starting right at its techno-mathematical foundations, instead of looking first at the dichotomy between „real" world phenomena and their digital representations. This change of focus holds the advantage that it by-passes philosophically problematic assumptions about the „world" or the human mind.[52]

Even Alan M. Turing once slippend into an archaeological metaphor when in his "Proposal for Development of an Automatic Computing Engine" he describes one process (which became mnemonic in the standard instruction tables) with BURY and UNBURY.[53] Michel Foucault's *Archaeology of Knowledge* (FO 1969, transl. 1972), though, is not related to digging out forgotten artefacts buried in past archives, but a technique of propositional logics; therefore, the appropriate way of rendering his passages intelligible is "obviously, to take the notion of a function at its mathematical face value"[54].

Any non-metaphoric notion of an "archaeology" of media-implicit knowledge is strictly techno-logic: a study of enuntiative functions, correlating symbols to an object field where they are enacted and repeated.

Such investigations into the conditions of possibilities (Immanuel Kant's *a priori*) of discrete computing not only refer to arithmetic but as well to its hard-wired logic operations, revealing the knowledge machine. Foucault's set of terms proposed for discourse analysis is itself a theory-machine: "I must discover whether the machine works, and what it can produce."[55]

Mathematician and philosopher George Boole's propositional "binary" truth value logic (Laws of Thought, 1854) has not been invented for computing but results from two-millenial philosophical reasoning; at the same time, epistemologically, the mechanization (and mathemacial formularization) of

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52 See p. 82 in Master thesis Nückel, op. cit.
53 In: A. M. Turing's ACE Report of 1946 and other papers. Volume 10 in the Charles Babbage Institute Reprint Series for the History of Computing, 20-105 (36)
54 Martin Kusch, Discursive formations and possible worlds. A reconstruction of Foucault's archeology, in: Science Studies 1/1989, 17-25 (17)
55 Michel Foucault, The Archaeology of Knowledge and the Discourse on Language, transl. from French by A. M. Sheridan Smith, New York (Pantheon Books) 1972, 135 f.

logics constituted a fundamental dis-continuity, culminating in Claude Shannon's 1938 master thesis on symbolical logic based on electro-magnetic relays which has been the engineering affordance for preferring binary logics to other forms of computing (such as ternary or even multi-valued, non-Aristotelean logics). Shannon demonstrated that Boolean algebra could be applied to the same types of problems for which Charles Babbage (who considered himself a philosopher[56]) had designed his mechanical notation system.[57] Shannon proved that techno-logical implementation can be isomorphous to Boolean algebra. What had been verbal philosophical reasoning in Aristotle's *Organon*, turned into electro-mechanics, thereby becomning autonomous of the human mind.

In electrified computing, a different kind of textuality returns. With electronics, the energy form of electricity does not count in its physicality any more, but used as binary logics (information). All of the sudden, wiring becomes writing again - a symbolic order (as identified in Claude Shannon's Master Thesis *A symbolic analysis of switching relais*, 19xxx).

What can be diagrammatically expressed in algebraic symbols can as well be implemented as real machine, as proposed already in Ramon Llull's *Ars Magna* concentric "paper machine"[58] of symbol-based argumentation and Leibniz' "dyadic" operations (designed, but never materially implemented) with the smallest alphabet of "0" and "1"; William Stanley Jevon's "logical piano" from 1869 has been no tool for experimenting the interrelation of "music & mathematics" in the Pythagorean sense, but an operative diagram of the implicit sonicity of philosophical reasoning itself.[59] The numerical sublime is mathematical calculation *in time* rather than Pythagorean musicality.

[The limits of computation as its chance]

Rather surprising for most users of communicational media which enjoy the seemingly unlimited power of data processing, digital computation originated from formalizing the limits of computation, by definition (*en arché*). This apparent deficiency can be revisited as a chance for a transformation of computational thinking, in favor of the affective and the unpredictable.[60]

56 Charles Babbage, Passages from the Life of a Philosopher. London: Longman, Green, Longman, Roberts, & Green, 1864. See Anthony F. Hyman, Charles Babbage, 1791-1871. Philosoph, Mathematiker, Computerpionier, Stuttgart 1987; Peter Berz, 08/15. Ein Standard des 20. Jahrhunderts, Ph.Diss. Berlin (Humboldt University) 1997

57 Jeremy Norman, Describing the Logic and Operation of Machinery by means of Notation, online http://www.historyofinformation.com/expanded.php?id=3179, referring to: Claude Shannon, A Symbolic Analysis of Relay and Switching Circuits, xxx

58 See Bernhard Dotzler, Papiermaschinen: Versuch über Communication & Control in Literatur und Technik, Berlin 1996

59 See Martin Gardner, Logic Machines and Diagrams, New York / Toronto / London (McGraw-Hill) 1958

60 M. Beatrice Fazi, Contingent Computation: Abstraction, Experience, and Indeterminacy in Computational Aesthetics, London (Rowman & Littlefield)

Algorithmic computing has been the first truly theory-born medium; its axiomatic basis has been renegotiated from the beginning. What looks like an oxymoron at fist glance, has been addressed by Gödel and Turing: the unresolved relation between the contingent and mathematical computation, resulting in a theoretical mechanism of computation. What later became known as *turingmachine* alias digital computer, resulted from a seminal paper from 1936 which in fact deals with the limits of what can be computed by numbers (and the existence of numbers that can not be computed), preceeded by Kurt Gödel's *incompleteness theorems* in 1931. From within, incompleteness and incomputability severely undermine Universal Computation, while at the same time reminding of its implicit epistemological ("axiomatic") beauty.

"Computational empiricism" (Fazi) considers computation as a Whiteheadian actual event, and enriches the ongoing debate by a daring philosophical approach to the apparent limits of digital computation, through the lenses of Alfred North Whitehead's "prehensional" ontology. Central conceptual terms in classic computing (like "Turing machine" or "algorithm" and its implementation, continuity vs. discreteness) are matched against the expanding field of unconventional computing (such as quantum computing and the renaissance of "analog" or "natural" computers where "change" and emergency are given a chance). Introducing "computational aesthetics" (Fazi) on the background of sound knowledge in computational engineering and applied mathematics, even Deleuzean philosophy - known for its distance to the subject of computing - can be reintroduced as a useful tool to rethink computational formalism in terms of "becoming". In man-machine communication, the human "me" confronts the computational "it". It will not only be the human readers interested in media philosophy but as well the ermerging non-classical computers themselves which will truly understand and appreciate such argumentation, with its message being self-fulfilled.

"Ready-to-hand": *techné* with Heidegger and "Object-Oriented Ontology"

The very term technology goes back to both *techné* and *lógos*. The bias of ancient Greek mathematical *lógos* has less been actual calculation but an inquiry into its theory[61] - a presence-to-hand which differentiates it from the operative readiness-to-hand of functional computing as tool (*Zeug*).[62] Heidegger's preferred example for technique which is ready-to-hand (German *griffbereit*), the hammer, is still an instrument coupled to transitive human performance; his technical ontology fails to take into account autopoietic electronic circuits respectively algorithmic media from within. True techno-poietics takes place *within* the operative techno-logical process itself.

Electronic circuitry including the triode or transistors, and their cybernetic

61 Johannes Lohmann, Musiké und Logos, Musikwissenschafliche Verlags-Gesellschaft, 1970, 11
62 Martin Heidegger, Sein und Zeit [*1927], 16th ed. Tübingen (Niemeieyer) 1986, 63

coupling for signal transduction in "electrified" system and communication theory, is an escalation compared with the humble *Zeug* or the trivial machine. Smart devices in ubiquitous computing are not simply *ready-to-hand* like the Heideggerean hammer any more; their agency not primarily performed by human action but becomes an auto-poietical operative regime. Media archaeological analysis opens the flat Integrated Circuit, making it *vorhanden* in terms of critial insight. This not simply requires mechanical circuit bending but as well logical unrevealing of codes (hacking).

Is there an equivalent to Heidegger's "readiness-to-hand" in digital computing? In "post-computational" times (in the sense of "post-digital"), with ubiquitous computing and mobile communication devices, the computer turns from an object of media-theoretical observation into an everyday thing, rather *zuhanden* (ready-to-hand) than *vorhanden* (present-to-hand).[63] For most consumers, a communicational device like the cell phone is literally "ready-to-hand", used without theorizing it. The term has been extended to "object-oriented philosophy" formally coined by Graham Harman in his 1999 doctoral dissertation "Tool-Being: Elements in a Theory of Objects". Heidegger's concept of "readiness-to-hand" refers to the withdrawal of objects from human perception into a different reality[64]; they thereby distance themselves from humans not only in cultural space but as well in their proper temporality (*Eigenzeit*); the technological world escapes from man-focused "history".

Technology only reveals itself to human perception in breaking down, when it goes from 'readiness-to-hand', being at our disposal (Heidegger) to articulating itself as a medium.

Media archaeologists listen to the technologically induced noise as the essential message from within the "medium" (channel) itself. While the signal-to-noise ratio in communication can be mastered by mathematical analysis, only in the moments of complete technological breakdown the *aletheía* of the operative machine is revealed. "The malfunctioning machine will be expressed only when experiencing the real physical machine (building it, repairing it); its operation is inextricably linked to its malfunctioning.[65] This leads to a core ontological question: Is digital computing capturing the essential operativity of the world (conceived as computational universe from Pythagoras to informational quantum physics), or is it rather its mathematical modelling (respectively diagram)? Metamathematics correlates with metaphysics, declaring its independence of the real physical world in numerically decribing abstract objects (David Hilbert), "but the actual information manipulation is still in the real physical universe"[66]. Here a radically different way of computational mathematics media-archaeologically re-occurs from the museum of "dead"

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63 Martin Heidegger, Time and Being [1927], xxx 1962, 91-107
64 http://en.wikipedia.org/w/index.php?title=Object-oriented_ontology&oldid=621455791; accessed September 8, 2014
65 As expressed in Morton Riis, Machine Music. A Media Archaeological Excavation, PhD dissertation, The Royal Academy of Music at Aarhus and Department of Aesthetics and Communication, Aarhus University, 2012
66 R. Landauer, Computation: A fundamental physifcal view [1987], reprinted in: Harvey S. Leff / Andrew F. Rex (eds.), Maxwell's Demon. Entopy, Information, Computing, Bristol (Adam Hilger) 1990,260-267 (262)

technologies: the *analog computer* which metonymically models physical events by physical rather than numerical and algorithmic means (such as voltage and condensers); it is itself part the world which it analyzes, just like in quantum computing, the mechanism does not symbolically abstract from the physical world (lithographic "inscriptions" in silicium), but calculates with the computer matter itself.

While canonical Object-Oriented Ontology (Harman) focuses on the immobile object, it shares its inquiry into the epistemology of matter with media archaeology but differs from its more process-oriented definition that technologies are in a *media state* only when in operation, that is: signal processing. The essence of media only unfolds in time. Ian Bogost's concept of "carpenty" refers to technological circuit bending as a way of operative media analysis in techno-logical experimentation; Morten Riis has enacted a case study by his invasive modifications of a cassette tape recorder.[67] From hard- to software, this practice-based media philosophical approach becomes truly computational when applied to the analysis of algorithms.

In his M. A. thesis *Fast Transformations. A media-archaeological and object-oriented investigation of Fourier-Transform algorithms*, Johannes Maibaum closely examines two algorithms that transform data between the time and the frequency domain in terms of "unit operations" (as defined in Ian Bogost's *Alien Phenomenology* 2012): Joseph Fourier's original series and the optimized fast Fourier transform (FFT), the latter being central to almost all computer-based communication technologies that are available today.[68] Different from classic mathematical Fourier Analysis, the computational effectiveness of the FFT grounds on an operation that cannot directly be identified in its formal listing of single steps, i. e. its source code. Instead, it is the time-critical minimization of the number of single operations by exploiting certain properties of the data to be transformed that allows for the algorithm's speed gain – an approach in modern computational design (known from ancient Roman empire power administration) as *divide-and-conquer*. In order to make such software engineering knowledge about the time requirements of algorithms available to media philosophy, Maibaum develops a neologism that extends Bogost's object-oriented approach of carpentry in a media-archaeological way: "the notion of algorithmic time, which is largely pre-determined by an algorithmic time coefficient" (author's *abstract*).

According to Object-Oriented Ontology, the object always withdraws; it is impossible to get access to its encrypted essence. But according to process(ing)-oriented ontology, such essence unfolds in time; media themselves become active archaeologist of knowledge.

Ian Bogost's applied ontology (or "carpentry"[69]) pairs with the anti-hermeneutic focus on micro-temporal analysis of real media apparatuses in media

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67 Morten Riis, Where are the Ears of the Machine? Towards a sounding micro-temporal object-oriented ontology, in: Journal of Sonic Studies, online: https://www.researchcatalogue.net/view/219290/219291

68 Humboldt University Berlin (2016); online http://edoc.hu-berlin.de/18452/18875

69 See Ian Bogost, Alien Phenomenology, xxx 2012

archaeology, that is: close observation and interaction with rudimentary aspects of technological *objets trouvés*. The machine's operations (its media archaeological *momentum*) are in its core un-historical; the specific time function of the machine is to some extent outside history and discourse. Each media event is inherently technological, not human.

Media archaeology experiences technologies not simply present-at-hand from a theoretical distance but as *operative* media analysis, thereby "ready" and "present" at the same time. The concept of "machine thinking"[70] refers to both a (finite state) machine's inner operation *and* in relation to its performance for humans. Conceptual media theatre is well suited to exploring the interplay between such modes of machine thinking, e. g. by enacting the Turing test as well as re-embodied chatbots.

The *present-at-hand* attitude to technologies is media *theory*, looking (*theoría*) at something. Such contemplative observing corresponds with the Cartesian way of measuring / mathematizing the world. However, with computational machines which mechanize mathematics itself, theoretical analysis (in numbers) is re-implemented in the physical world (that is, in time / being) again.

Presence-at-hand is not the way digital technologies in the world are usually encountered. It is only revealed when, e. g., a hard disc drive within a computer breaks down; then "it loses its usefulness and appears as merely there".[71] In a transfer of Heidegger's terms[72], the digital computer can be used as a tool only when it is *zuhanden*, that is: not reflecting its modalities. But different from the Heideggean hammer, a technological medium is not simply a mechanical tool any more.

A mere description of a technical object, according to Heidegger, is simply a mis-description[73], as opposed to its operative experience ("verweilender Umgang"), in its present (con-)temporality[74]. An electronic medium such as the radio is in its medium state (different from the ancient definition of the physical medium) only when transducing signals; the passive, Aristotelean notion of "medium" different from the "thing"[75] thereby turned media-active, media-dramaturgical. In a different way, this is true for computational data processing (the difference between signal transduction and discrete algorithmic steps). When thereby "in being", any technology is except from historicity. The

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70 As being developed in Ioana Yucan who is currently completing her PhD in Theatre and Performance Studies at Brown University

71 For an application of this thought to computing, see Terry Winograd / Fernando Flores, Understanding Computers and Cognition, Norwood, N. J. (Ablex) 1986

72 Martin Heidegger, Sein und Zeit, 19th edition, Tübingen (Niemeyer) 2006, 70 f.

73 "[e]ine Fehldeskription der alltäglichen Welt": Martin Heidegger (Gesamtausgabe, im Band Ontologie), Hermeneutik der Faktizität, Frankfurt/M. (2nd ed.) 1995, § 19, 88 f.

74 "in der Zeitlichkeit der Alltäglichkeit": Heidegger 1927: 90

75 See Fritz Heider, Ding und Medium, in: Symposion, Bd. 1, Heft 2 (1927), 109-157

ontological question ("What *is* a medium?") misses the essence of technology, its being in time and being a time-object itself.

Re-turn from phenomenology to processual ontology

Seen from a distance, the field of "new media" philosophy and theory seems split between two different approaches. Techno-centric media archaeologists describe the non-discursive practices of the techno-cultural *archive* in the Foucauldean spirit, while media phenomenologists in the anthropocentric, performative perspective "analyze how phenomena in various media appear to the human cognitive apparatus, that is, to the mind and senses."[76] Phenomenology stays close to the embodied affective signal indeed, while media archaeology traces effective signal processing as implemented in technologies. For Heidegger, up-dating the etymological root, phenomenology literally encourages to let that which shows itself be seen from itself (*Being and Time*, 1927). An epistemology of techological media derives sparks of knowledge from within the techno-logics.

Philosophy in times of mathematical computation breaks with phenomenology. James Clerk Maxwell's differential equations (his paper "A Dynamical Theory of the Electromagnetic Field" from 1865) have been the computational tool to master the phenomenon of what Michael Faraday has called the "field", i. e. the sphere of electro-magnetic interaction and induction. Instead of empirical study with a mechanical model (as preferred by Maxwell before), mathematics itself became the model of an inivisble event event with symbolical means (operators).[77] Finally, the computer itself is derived from mathematical deduction: the first theory-born machine. Beyond the static Pythagorean empirico-philosophical equation (harmonic order in integer number ratios), the processual derivate of meta-mathematics (the algorithm as machine) became a worldly medium.

Ontology has been the philosophical inquiry into the nature of being as existence and becoming. As a philosophical enterprise is has been, so far, highly hypothetical, but gained "practical application in information science and technology, such as ontology engineering"[78] which deals with formal representations of a set of concepts within the domain of temporal action. With applied ontology[79], a core concept of occidental philosophy has become functional and adaptive to the changing underlying algorithmic domain.

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76 Kjetil Jakobsen, Anarchival Society, in: Eivind Røssaak (ed.), The Archive in Motion. New Conceptions of the Archive in Contemporary Thought and New Media Practices, Oslo (Novus) 2010, 127-154 (141), referring to Wendy Hui Kyong Chun / Thomas Keenan (eds.), New Media, Old Media. A History and Theory Reader, New York / London (Routledge) 2006, 3 f.
77 See Hugh G. J. Aitken, Syntony and Spark. The Origins of Radio, New York / London / Sydney 1976, 21
78 Wikipedia, entry "Ontology", accessed May 2017. See as well Frans Smit et al. (eds.), Philosophy of Information Aesthetics, forthcoming (2017)
79 Wikipedia, entry "Ontology engineering", accessed May 2017

While in its root meaning, phenomenology is the study of *phenomena* (appearances as opposed to reality, specified in the philosophical model of Plato's cave) and linked to empirical, especially sensory appearances, Edmund Husserl took up the term for a science of consciousness and subjective embodied action, especially the complex procedures of temporal awareness

Media archaeology, on the contrary, does not begin the inquiry into the meaning of being in the anthropocentric sense, examining human existence, but object-oriented, granted a definition of media that a technological device is in "media being" only when in action (that is, signal processing).

Media archaeology learns from posing the philosophical question in Heidegger's *Sein und Zeit* but extends and specifies it to the question of computaitonal media tempor(e)alities.

In 1936 the "invention" of the computer (symbolical machine) has been a by-product of Alan Turing's answer to the problem of the mathematically undecidable: "Computable" numbers are those which are calculabe by *finite procedures*. The question if there is an algorithm capable to decide whether a mathematical procedure can have a sense of ending (the *Halteproblem*) leads to the more general consideration of media-induced temporality. Computational systems internally develop new forms and operatations of temporal sequences and a different notion of "ending" (recursive functions, real-time operations) and enact a micro-dramaturgy of synchronizations where smallest bits of time are decisive ("critical") for the success of the whole media event.

Media theory replaces the ontological definition of media by a dynamic one: media-in-being, its temporal mode of existence, a technical implementation of Heidegger's philosophical claim.[80] Continuous or discrete processuality is the core definition of electro-mechanic and electronic media as such.

Close to mathematics: combinatorial reasoning

For ages, philosophy has been primarily performative as a cognitive procedure, while computing is operational (even when taking place with a human coupled to paper by a pencil equipped with an eraserhead), until Leibniz dreamt of a way to express philosophy algebraically and to communicate by mathematical formulas, in symbolic language (*characteristica universalis*) ("per Artem Combinatoriam"):

The media-archaeological question therefore is put into this form: To what degree is computation still rooted in philosphy, or does it depart from any "speculative" realism, with a veto? Is philosophical analysis essential to the origin of algorithmic computation itself, assuming that methodological reasoning is algorithmic already? For Babbage as well as for Turing, the

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80 "Um dem Seinscharakter dessen, was hier Thema ist, zu entsprechen, müssen wir von der Zeit zeitlich reden <...>. Die Zeit ist das Wie." Martin Heidegger, Der Begriff der Zeit, lecture Marburg 1924, quoted here from: Hartmut Tietjen (ed.), Der Begriff der Zeit, Tübingen (2nd. ed.) 1995, 27

symbolic (algebraic or diagrammatic) representation of the machine is (or can be) the same as the machine itself.

As opposed to the universal discrete machine named computer the *ars combinatoria* of the Baroque era has not been able to calculate by itself, nor was it capable of effectively storing intermediary results or to be programmed. The coupling of machines and mathematics here has not yet led to a to a mathematization of the machine, but simply to a mechanization of mathematics.

Henri Bergson had been concerned with what happens when in intellectual history, the "spiritualization of matter" will, in reverse, flip to the materialization of the mind.[81] Cybernetians frequently took mathematical machines for thinking machines, which meant automatisation of mathematical intelligence as opposed to the trivial mathematization of mechanical tools. Simple mechanics may be able to implement simple calculating rules or algorithms, such as the four-species-machine which Leibniz presented to a the Royal Society successfully translated the Indian-Arabic counting system by ciphers into a hardware of decadic cog-wheels. But this flow of numbers between mechanical wheels is not yet a program which would be able to start, control and finish calculations on its own account, while a digital computer can be structurally programmed[82]; logic of engineering is one aspect and another one is the engineering of logic (modelling or the building of logical machines).

Combinatorical reasoning, as described in his *Dissertatio de arte combinatoria* by Leibniz in 1666, aimed at reducing all reasoning and discovery to a combination of basic elements such as numbers, letters, sounds and colour, but has not been able to calculate on its own, even less to store data in RAM or registers. The coupling of machine and mathematics that enabled the creation of computers occurs as a mathematization of the machine itself, not as a mechanisation of mathematics.

Technologies once changed from tools to machines, then to "symbolical machines" (algorithms).[83] Any archaeology of contemporary media culture is therefore as close to mathematics as it is to phenomenology. In alliance with George David Birkhoff who on the congress of mathematicians in Bologna 1928 delivered a lecture proposing a measure for aesthetic perception (so-called "Gestaltmaß") as ratio between order and complexity[84], philosophers like Max Bense as well as artists made cybernetics and aesthetics converge.[85] *Onto-*

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81 Henri Bergson, La signification de la guerre, Paris 1915, 20; see Friedrich Kittler, Die Nacht der Substanz, Bern (Benteli) 1989, 30

82 Friedrich Kittler, Hardware, das unbekannte Wesen, in: Lab. Jahrbuch 1996/97 für Künste und Apparate, edited by the Academy of Media Arts, Cologne 1997 (Walther König), 348-363 [paraphrase W. E.]

83 See Sybille Krämer, Symbolische Maschinen: die Idee der Formalisierung in geschichtlichem Abriß. Darmstadt 1988

84 "Quelques éléments mathématiques de l´art", reprinted in: The collected mathematical papers of G. D. Birkhoff, published by the American Mathematical Society, vol. 3, pp. 288-306 (1968)

85 *When Cybernetics meets Aesthetics* has been the title of a conference organized by the Ludwig Boltzmann-Institute for Media.Art.Research at Linz

aesthetics is the belief that works of arts can disclose their ontology"[86]. Onto-techno-analytics, while being aware that all technological artefacts are emanations of cultural knowledge, aims at a "culture-free" understanding of computational events. The Object-Oriented Ontology approach hereby equals media archaeology.

Materialist philosophy: Is dialectics computable?

There has already been developed a couple of technical "philosophies" such as Gilbert Simondon's *Du Mode d'Existence des Objets Techniques, Paris (Aubier) 1958*, or Maurizio Lazzarato's Bergsonean *Videophilosophie*[87], but only in computing happens the marriage of engineereing (*techné*) and mathematics (*logos*). Any archaeology of the computer and its programming practice oscillates between two poles, the mathematization of machines and the mechanisation of mathematics. "The *logic of engineering* is one aspect of technical logic and another one *is the engineering of logic* that is *logical modelling* or the building of logical machines."[88] This is one reason for the rupture between the developers of computer engineering (typically electricians) and the mathematicians working on meta-calculations, unable to affect the development of computing engineering.[89]

Rather than just being a modification induced "after" the arrival of mechanized computation, stored program computing (Babbage's Analytic Engine and the Von-Neumann architecture) disrupted the philosophical cosmos.

The notion of matter, so hard thought through by G. W. F. Hegel, dissolved into matter and mathematics (like the very meaning of "techno/logy", reminding of the Aristotelian distinction between *logos* and *physis*). Just in the very epoque when Charles Babbage was about to extend his arithmetical *Difference Engine* to an storage-programmable, thus algorithmic *Analytical Engine*, G. W. F. Hegel who opposed the idea that the act and procedures of thought might be - as expressed later in Boole's *Laws of Thought* - performed by a logical machine (rather than by "working through" in philosophical terms) regarded mathematical machines which claimed intelligence as a provocation.[90]

(Austria), 31 August 2006, on occasion of the Ars Electronica festival of media arts.

86 Brian Kane, Sound studies without audiotory culture: a critique of the ontological turn, in: Sound Stuides vol. 1, No. 1 (2015), 2-21, referring to Christoph Cox, Greg Hainge, and Steve Goodman's "vibrational ontology"

87 Maurizio Lazzarato, Videophilosophie. Zeitwahrnehmung im Postfordismus, Berlin (b-books) 2002

88 Gellius N. Povarov, Logic, automation and computing, in: Alexander Nitussov et al. (eds.), Computing in Russia, Braunschweig (Vieweg) 2xxx, xxx

89 Stanslav V. Klimenko, Computer Science in Russia: A Personal View, in: IEEE Annals of the History of Computing, Vol. 21, No. 3 (1999), 16-30 (24)

90 On "computing with numbers" see , see G. W. F. Hegel, Wissenschaft der Logik, vol. 1: Die Lehre vom Sein (1832), ed. Hans-Jürgen Gawoll, Berlin (Akademie-Verl.) 1990, 230

But within the algorithmicized computer, calculation and intelligence converge.[91] As long as the computer is seen desintegrated in an electronic waste deposit, it is indistinguishable from other fragments of ("analoge") electronics. Its specificity is not in its hardware materiality, but in its algorithms, which might be performed in organic mattes as well (such as the DNA computer). If future archaeologists disover among the ruins of Berlin strange artefacts which look like electronic devices, they probably miss their essential interpreation as computers. What (literally) *matters* for computers? Is it mathematized matter or material mathematics ("mathematische Maschinen")? The Turing machine is a heuristic fiction, but it has to take place on paper and with ink at least. Diagrammatic resoning is never purely intellectual but as operation depends on the material trace to take place.

Heinrich Hertz' theorem of conceptual modelling[92] corresponds with Charles S. Perice's definition of *me/diagrammatical resoning* as "[...] reasoning which constructs a diagram according to a precept expressed in general terms, performs experiments upon this diagram, notes their results, assures itself that similar experiments performed upon any diagram constructed to the same precept would have the same results [...]."[93]

Each medium needs some physical or biological embodiment (implementation) to be operative, that is: to be a medium (in performance). But "implementation", in software science, does not mean physical embodiment, but rather "the realization of a technical specification or algorithm *as a* program (that is: software). For example, Word Wide Web browsers contain implementations of WWW Consortium recommended specifications, and software development tools contain implementations of programming languages"[94].

In his preface to Gotthard Günther´s publication *Das Bewußtsein der Maschinen. Eine Metaphysik der Kybernetik*[95], Georg Klaus (holding the chair of Philosophy of Logics at Humboldt-University in East-Berlin) counter-attacked, "prompted by the fact that the second edition of *Das Bewusstsein der Maschinen* contained an added chapter on dialectic materialism in which the author of this Proposal suggested that it should be possible to test the validity of the dialectic theory by translating it into a formal algorithm of mathematical logic. Both Marxist authors insisted that this was not only contrary to the spirit of Marxism and Leninism but also technically impossible; because, according to Hegel, dialectic theory is not capable of formalization"[96].

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91 "Mechanisierung des Geistes und Vergeistigung der Materie fallen seitdem zusammen." Kittler 1989: 31

92 Heinrich Hertz, Die Prinzipien der Mechanik in neuem Zusammenhange dargestellt, Leipzig 1894, 1

93 Charles S. Peirce, The New Elements of Mathematics, vol. IV: Mathematical Philosophy, The Hague / Paris (Mouton) / Atlantic Highlands, N. J. (Humanities Press) 1976, 48

94 http://en.wikipedia.org, entry "Implementation"

95 Krefeld / Baden-Baden (Agis) first edition 1958, second edition 1963

96 Quoted from the typoscript: PROPOSED: To develop a mathematical calculus of dialectics to anticipate recent Marxist intentions in this field since they are aiming at new technical designs in Cybernetics, in: Estate of Gotthard

"Information is information, not matter nor energy, and any materialist philosophy which does not recognize this cannot survive these days", Wiener declares in his *Cybernetics* (1948). Different from mechanic engines driven by steam or electric force as known from industrial modernity, trans-classical machines (Gotthard Günther) are primarily devices for processing binary information. Abraham A. Moles on "machine art" expressed a cybernetic understanding of the machine which is no longer reduced to matter and energy transformation but first of all an informational device.[97] "We are presently facing [...] a revolution of *automation*, [...] of *symbiosis with machines* [...], a 'secret revolution' in the sense that those who are part of it - all of us -. were unaware that it was going on"[98]; the technol-logical works at its best in a mode well known from ancient rhetoric (definined by Quintilian) as *dissimulatio artis*.

Human hands actually get *off* instruments by automation. Machinic typewriting had differentiated the hand(s) into ten discrete fingers. Finally the binary code reduces decimal fingers to two. What still looks like a playful *performative* handicraft, in reality is already a techno-mathematical *operation*. While fingers hack such thoughts in symbolical code on the keyboard of a laptop, the media-archaeological distance is aware that most writing is done within the micro-processors themselves where algorithms reign. Different from a typewriting machine which is still an instrument, the computer has already become what Gotthard Günther once called the *trans-classical machine*. When discretely (not diagramtically "analog") calculating either in his mind or when coupled to pen, eraser and quare paper, man is already in a (Turing) machine state.

The initial statement in Semen Karsakov's *Aperçu d'un procédé nouveau d'investigation au moyen de machines à comparer les idées* (St. Petersburg 1832) declares: "L'homme pense et ses actions sont machinales." Speech and writing "ne sonst que des opérations mécaniques de l´intelligence"; follows a truly media archaeological definition of writing as "fixer les idées sur la matière". Digital computers are, as Hegel might say, instantiations of an "objective mind".[99] Such second-order machines are different from the thermodynamic engines; logical mechanisms *invite* to be materialized as techno-logic, just as Charles S. Peirce designed first electric circuit diagram for logical reasoning. *Diagramatic reasoning* (Peirce) of media-in-being results from symbolic notations which are themselves already symbolical machines, as

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Günther, Staatsbibliothek (Preußischer Kulturbesitz) Berlin, file 471, 1

97 Abraham A. Moles, Introduction to the colloquy *Computers and Visual Research*, Center for Culture and Information, August 3-4, 1968, Zagreb, in: Margit Rosen (ed.), A Little-Known Story about a Movement, a Magazine, and the Computer's Arrival in Arts. New Tendencies and Bit International, 1961-1973, Karlsruhe (ZKM) / Cambridge, Mass. (MIT) 2011, 263-266 (263)

98 Moles 1968 / 2011: 264

99 "Objektiv insofern, als es ein materielles Stück der Außenwelt ist, und Geist insoweit, als die Natur von allein keine Werkzeuge hervorbringt [...].": Gotthard Günther, Die "zweite" Maschine. Kommentar zu Isaac Asimov, Ich, der Robot, Düsseldorf / Bad Salzig 1952, 219-242 (220). For a modified version see same author, Das Bewußtsein der Maschinen. Eine Metaphysik der Kybernetik, Krefeld / Baden-Baden (Agis), 2nd edition 1963, supplement IV (Die "zweite" Maschine), 179-203

designed and commented in the 1842 "Sketch of the Analytical Engine invented by Charles Babbage" by L. F. Menabrea, Turin.[100] On the previous Difference Engine it says: "The drawings are nearly finished, and the mechanical notation of the whole, recording every motion of which it is susceptible, is completed"[101], as "operative writing" (Sybille Krämer). This correlates with Alan Turing's model of the (both human / non-human) *paper machine*.

Man becoming inhuman in the calculating state

With step-wise "digital" calculations in the mind or on paper, humans are (momentary) in machine states. The Turing machine is not an extension or prosthesis of human organs; it rather equals the definition of humans as speech-articulating beings: as indicated by the very term "programming language", culture has generated machines which can operate what has been unique privilege of humans so far: operating with symbols in a language-like way.

Writing, reading and culculating is "elementary" cultural techniques. But man, endowed with paper, pencil and eraser, when calculating, is in a machine state - revealing the mechanism within the "human" itself. A machine is not simply cultural technique any more but a techno-logics of its own. It makes a time-critical difference when this process is implemented into non-human procedures: not conceptual, but actual *computing*. All of the sudden, a world in itself unfolds with all its break-downs, side-effects, unknown phenomena, achievements, timing (ahistorical temporealities). Such implementations are cultural products; technique is always cultural already, but results in a different kind of the physical un-natural: the symbolic implemented in the real.

Different from applied "cultural techniques" such as geometry, there are techno-epistemic constellations in terms of Process-Oriented Ontology like the notorious Turing machine as. This machine (inviting for "carpentry" in Ian Bogost's sense) has been modelled in 1936 not to solve a concrete numerical operation like calculating mechanisms so far, but as a meta-mathematical tool, equalling algorithm with machine.

There is philosphical reasoning *with*(*in*) computation. Philosophy becomes inhuman when coupled to / with a machine, thereby constituting a cybernetic system, with the human lending counsciousness to the machine (an argument by philosopher of multi-valued, trans-Aristotelean logic ("kenogrammatics") Gotthard Günther. In a letter to Kurt Gödel from May 23, 1954, Günther declares symbolic mathematical logic as condition for philosophical metaphysics.[102]

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100 Orig. in the *Bibliothèque Universelle de Genève* Nr. 82, Oktober 1842

101 "Sketch of the Analytical Engine invented by Charles Babbage" durch L. F. Menabrea, quoted here after Bowden (ed.) 1971: 342 (Appendix) <cheque>

102 Kurt Gödel, Correspondence A-G, in: Solomon Feferman et al. (eds.), Collected Works, vol. IV, Oxford 2003, 456-535

Computational technology is not simply an extension of human thinking into material objects but is trans-subjective tools for operative reasoning which in its complexity can not be performed by humans themselves.

Ada Lovelace de-coupled mechanic computing of mathematics from the human hand/mind, and from the "subject" in both meanings: "The science of operations [...] is a science of itself, and has its own abstract truth and value, just as logic has its own peculiar truth and value, independently of the subjects to which we may apply its reasings and processes"[103];

The "trans-classic machine" *alias* digital computer can perform functions of consciousness; self-consciousness it gains rather by its coupling with the engineer.[104]

Re/thinking computation in philosophical terms: cybernetic reasoning

Cybernetics can not be reduced to a historical discourse of applied engineering, but in the tradition of Norbert Wiener, it is both a mathematical and a philosophy. Heidegger has been well aware of the transition from *techné* as handicraft (cultural techniques) and "Kraftmaschinentechnik" (thermodynamic machines) to "'Automation", essentially defined by cybernetic communication and control.[105] Confronted with cybernetic thinking, Heidegger "conceptualized the beginning of computers as the factical end of phislophy itself"[106]. Man (as mathematicians, or technicians) vanish themselves into the machines.[107] With the algorithm itself identified as "machine"[108], a challenge to traditional philosophical reasoning arose. (Meta)Mathematics displaced discursive philosophy by logics in formal (and formular) languages.

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103 James Essinger, A female genius: How Ada Lovelace, Lord Byron's
    daughter, started the computer age, London (Gibson Sqiuare) 2014, 173
104 Maschine, Seele und Weltgeschichte, in: Gotthard Günther, Beiträge zur
Grundlegung einer operationsfäigen Dialektik, vol. 3, Hamburg (Meiner) 1980,
211-235
105"Was hier überall der Name Technik meint, ist nicht ohne weiteres klar." =
    Martin Heidegger, Überlieferte Sprache und Technische Sprache [lecture
    1962], St. Gallen (Erker) 1989, 10
106 Friedrich Kittler, Towards on Ontology of Media, in: Theory, Culture &
Society vol. 26, no. 2/3 (2009), 23-31 (24)
107 "Seit Alan Turing 1954 Selbstmord begann, heißt die *Turing machine* schon
turing machine." Friedrich Kittler's talk "Phänomenologie versus
Medienwissenschaft", http://hydra.humanities.uci.edu/kittler/istambul.html,
referring to: Andrew Hodges, Alan Turing: The Enigma, London 1983, 530
108Alan Turing, On Computable Numbers, with an Application to the
    Entscheidungsproblem, in: Proceedings of the London Mathematical Society
    (2), vol. 42 (1936), 230-265, and vol. 43 (1937)

While technique (or cultural techniques[109]) is still body-related (as extensive *handling*[110]), technology in its true sense is the marriage of in-formed physics and *logos* (mathematics, logic circuitry). This relation has been radically turned upside down by the Turing machine: techno-mathematics is not simply the mechanization of mathematical calculation (like in ancient calculating machines since the Antikythera mechanism) but revealing the machinic within mathematical reasoning itself - a "sphere of *Berechenbarkeit*" (Thomas Nückel) which challenges the sphere of philosophical thinking.

Cybernetics is rooted in philosphy, engineering and mathematics: a trinity which asks for media-epistemological unfolding. The ambition of primary cybernetics (before it split into separate, therefore epistemologically reduced fields like second-order cybernetics, computational science, neuro-science, technical informatics et al.) has been to embrace computing both mathematical, electro-technical, and mathematical (case Gotthard Günther). It is therefore mandatory to media-archaeologically de-historicize to cybernetic approach in order to rescure it from being reduced to a simple chapter in the history of ideas.

"Treat time as discrete": Towards a computational epistemology of tempor(e)alities

Philosophy of technology and / or computation? Ernst Kapp's *Grundlinien einer Philosophie der Technik. Zur Entstehungsgeschichte der Cultur aus neuen Gesichtspunkten* (1877) ends up calling the steam engine the "machine of machines", while Karl Marx, in his so-called *Machinen-Fragment*, in response to Charles Babbage's media economy of computing, even addressed the automaton. This is the point that marks the closing of the technological feedback loop: the autopoietic emancipation of technical media from their direct link to a cultural environment. Bense called this cybernetic revolution "machine metatechnics"[111] – something that detaches itself from cultural history on its own terms. Thus media technology gains autonomy from culture, in the cybernetic marriage of machine and mathematics.

Object-oriented ontology actually rejects the privileging of human existence over the existence of non-human objects.[112] In a rather (hypothetical) media-centric view, object-oriented philosophers - somewhat in alliance with media archaeology - "maintain that objects exist independently of human perception

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109 See Theory, Culture & Society, vol. 30, no. 6 (November 2013), Special Issue *Cultural Techniques*, edited by Jussi Parikka / Geoffrey Winthrop-Young
110 "*'Technik' im weisteren Sinne*: handwerkliches, werkzeugliches Arbeiten; Gerätegebrauch <...> *téchne*, Sichauskennen in der Handhabung, Können, 'Kunst'": Martin Heidegger, Leitgedanken zur Entstehung der Metaphysik, der neuzeitlichen Wissenschaft und der modernen Technik [= Gesamtausgabe, vol. 76], Frankfurt/M. (Vittorio Klostermann) 2009, 293
111 Max Bense, Kybernetik oder Die Metatechnik einer Maschine, in: Ausgewählte Schriften, vol. 2: Philosophie der Mathematik, Naturwissenschaft und Technik, Stuttgart 1998, 429-446
112 https://en.wikipedia.org/wiki/Object-oriented_ontology; accessed 11 May 2017

and are not ontologically exhausted by their relations with humans or other objects"[113].

From a cult(E)urocentric perspective, a book without human reader might be a meaningless object. But in Charles Babbage's sense of computing, "logarithmic tables can be generated by a computer and be printed. These numbers may probably never be read by humans on earth."[114] but incorporate what Popper termed as "objectives knowledge". Such a computational world does not require the human subjects in order to be known, and indeed recalls the hypothesis of *anamnesis* in Plato's philosophical dialogue Menon. "Even though this [...] world is a human product, there are many theories in themselves and arguments in themselves [...] which have never been produced or understood and may never be produced or understood by men."[115]

In his most radical thought experiment, Popper envisions even the storage media of knowledge destroyed (like in antiquity the library of Alexandria including its philosophical machines): "there will be no re-emergence of our civilization for many milennia."[116] Machines may have been completely destroyed, but techno-mathematical machines (alias computer) are of a different kind, as expressed in Babbage's vision of the universe itself as Analytical Engine. "Knowledge in this objective sense is totally independent of anybody's claim to know."[117]

Manuel De Landa envisioned a future "robot historian"[118]; to what degree may computational machines become themselves future techno-philosophers, displacing human philosophy of technology? Technology implicitely knows more than humans who have to invent it in order to turn it into explicit knowledge.

Once human senses are coupled with a technological setting, man is within its autopoietic temporal field[119], a chrono-regime of its own almost sonic dynamics or mathematics, when data are registered digitally.

Such couplings create moments of literal ex-ception: Man is taken out of the man-made cultural world (which is Giambattista Vico's definition of "history") and confronts naked physics and / or pure logical reasoning.

Mathematics and technologies of computation are a core concern of a contemporary media theory. That necessarily leads to anachronisms in its re-

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113 https://en.wikipedia.org/wiki/Object-oriented_ontology (accessed 11 May 2017), referring to Graham Harman's 1999 doctoral dissertation *Tool-Being: Elements in a Theory of Objects*
114 Popper 1979: 115
115 Karl R. Popper, Objective Knowledge. An Evolutionary Approach [1972], Oxford, 2nd. ed. (Clarendon Press) 1979, 116
116 Popper 1979: 108
117 Popper 1979: 109
118 Manuel DeLanda, War in the Age of Intelligent Machines, 1991
119 "Wenn der Mensch nur dort ganz Mensch ist, wo er spielt, so wird auch er, wenn sein Mitspieler Automat ist, zum Unmenschen": Friedrich Kittler, entry "Flipper", in: Baggersee. Frühe Schriften aus dem Nachlass, ed. Tania Hron / Sandrina Khaled, Paderborn (Fink) 2015, 58 f.

reading of technologial genalogies. While so-called "analogue" media such as telephony, radio and television (based on electro-magnetic waves) had intervened in modern communication culture and apparently made obsolete the printed book culture and telegraphy, with computing, the "digital" recurred, recalling the ancient alphabetic "technologizing" of speech[120] and the discrete telegraphic code, but in a dialectically new form: processed algorithmically.

Gilbert Simondon at a conference on "machinology" declared: "There is something eternal in a technical schema [...] and it is that which is always present and which can be preserved in a thing."[121] A media archaeology of digital "machines" (in both senses as archaeology *of* the digital and knowledge archaeology *by* digital media) reveals principles and commands (the *arché*) within the techno-mathematical field, with a focus on the innertemporal, time-critical axis, that is: the *chonopoetics* of algorithmic media, while at the same time questioning the being of technologies in culturally emphatic, symbolic, "historical" (historiographical) time.

Philosophy in time(s) of computing questions a core ontology of occidental philosophy since Greek antiquity: time. When being in an operative, signal-transducing (analog) or signal-processing (digital) state, any technology assumes autonomy and is phenomenologically "bracketed" (Husserl's term for ancient Greek *epoché*) from cultural, that is: "historical" and human time (to which software pays respect by the interfacial "interrupt" order).

The "post-computational", taken literally, refers to the challenge of preservation of digital heritage. Every digital object is a trinity of physical, logical and conceptual object.[122] Object-oriented philosophy here extends to a different epistemology of time (missed by previous philosophy of history). When extended to "deep" temporality (*alias* cultural history), the techno-logical being in the world as time-objects provides them with the option of equiprimordiality, since their actuality ("event") can be a-historically re-enacted. In that context, the emulation concept for the preservation of "post"-computational heritage (such as computer games: their hardware, their operative system, their software) represents an epistemological new concept produced by computing culture itself. With "emulation", computing culture contributes an epistemological neo-logism to contemporary philosophy of (im/material) media.

Next to ontology, epistemology, logics and phenomenology, remains ethics as branch of philosophical reasoning. In times of computing, this disguises in the name of "media ecology". While the energy consumption and material recycling involved in computing technologies remain external to its key

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120 Walter J. Ong, Orality and Literacy. The Technologizing of the Word [*1982], New York (Routledge) 2000
121 Gilbert Simondon, in: Cahiers du Centre Cultural Canadien No. 4 (Deuxième Colloque Sur la Mecanologie), Paris 1976, 87; Übersetzung: John Hart, Vorwort zu: Gilbert Simondon, On the Mode of Existence of Technical Objects [franz. Orig. Paris 1958], University of Ontario, 1980.
122 Kenneth Thibodeau, Overview of Technological Approaches to Digital Preservation and Challenges in Coming Years; http://www.clir/pubs/reports/pub107/thibodeau.html (accessed May 2017)

operator which is information, the micro-relation between informational and thermodynamical entropy (down to quantum computing) is a much more delicate one. Maxwell's demon appears not in the reading but in the erasure of information from computer memories. A philosophical or mathematical text composed by Leibniz, Boole or Turing ages away in thermodynamic terms (the irreversible "historical" time arrow), but a human or non-human time-modulated reading of such texts only requires energy which is sub-critical to its informational enunciation.[123] It has been Turing himself who advised: "Treat time as discrete."[124] So we end within a computational time which is both a function of the alphanumeric code and of discrete clocking. Any analysis of philosophy in times of computing has to regard this *en arché*.

TECHNOMATHEMATICAL IMPLEMENTATIONS. Non-human forms of embodiment

A focus on time-critical signal processing in humans and machines

A *science of embodiment* leads to the analysis of time-critical signal processing both in animals and in machines (encompassing both electronic and technomathematical systems), thus reactivating previous cybernetic assumptions under the specific perspective of such micro-tempor(e)alities. The expression "in animals and machines" of course alludes to the programatic sub-title of Norbert Wiener's *Cybernetics* of 1948.[125] Signal processing as a topic of applied mathematics - in the neo-cybernetic sense - does not refer to electrical engineering only, but to organic bodies as well.[126] Signal analysis (the basic archaeological level, with signals being defined as time-varying or spatial-varying physical quantities) then turns into an active mastering: operations on signals. Signals of interest range from sound, images, sensor data to telecommunication (such as radio signals). Technical media, in this context, act as agents of signal analysis: biological data (from the human body) are retrieved (and transformed) by time-varying measure media (such as sonography, electrocardiograms).

Mico-tempor(e)alities: Vibrating nerves, vibrating strings

The memory technique in oral poetry performances by singers of tales relies on senso-motoric synchronisation and feedback, sometimes significantly coupled with a string instrument (Homer in Greece, *guslari* in ex-Yugoslavia). "Aucune

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123 See Rolf Landauer, Information is physical, in: Physics Today (May 1991), 23-29 (25)

124 Alan Turing, Proposal for Development in the Mathematical Division of an Automatic Computing Engine (ACE), in: B. E. Carpenter / R. W. Doran (eds., A. M. Turing's ACE Report of 1946 and other Papers, Cambridge, Mass., et al. (MIT Press) 1986, 20-105 (23). See as well Timothy Scott Barker, Time and the Digital. Connecting Technology, Aesthetics, and a process Philosophy of Time, Hannover, New Hampshire (Darmouth College Press) 2012

125 Norbert Wiener, Cybernetcis or Communication and Control in the Animal and the Machine, 1948

126 See, for example, J. D. North, Application of Communication Theory to the Human Operator, in: Colin Cherry (Hg.), Information Theory. Papers read at a Symposium on 'Information Theory' held at the Royal Institution, London, September 12th to 16th 1955, London (Butterworths Scientific Publications) 1956, 372-389

activité de la matière ne peut échapper au rhythme" (d´Udine[127]). "La diffusion nerveuse est comparable à la propagation du courant électrique à travers un réseau de fils conducteurs."[128] The subject of *embodiment* as form of *kinesthetics* epistemologically activates the assumption that both machines (technical or mathematical) and animals are governed by analogous feedback-processes. "By consistently embracing all these technologies, we inevitably relate ourselves to them as servomechanisms"; as such, e. g., the businessman becomes a servomechanism of his clock, and explicitly "the cyberneticists - and soon the entire world - of his computer". McLuhan concludes: "This continuous modification of man by his own technology stimulates him to find continuous means of modifying it [...]. Man's relationship with his machinery is thus inherently symbiotic" - a shift of perspective from body-centered to system-orientated *embodiment*.[129] J. C. R. Licklider, in 1960, declared this man-machine symbiosis explicitly.

[*Guslari* on wire]

Media archaeology is aware that media culture, when dealing with the past, is confronted with technological memory, not with humans; that one is not speaking with the dead but un-dead media still operate. Whereas the scripture-based classical archive is a static array of records on the grand scale and letters on the microscale, which can be activated only by the act of human reading line by line, the Edison phonograph is the first form of a truly "performative" archive in motion[130], since its recording (notably the early ethnographic field recordings around 1900, leading to the Vienna Phonograph Archive and the Berlin Phonogramm Archive) is based on a rotating, technically moving apparatus both in recording and in re-play.

As opposed to an "archival" transcription of, for example, oral poetry by alphabetic or musical notation, its recording by phonograph or gramophone creates a presence in latency, a different temporality, since these sources can be re-played with equiprimordially: Repetition with difference on the macro-temporal time axis, but identical reproduction of its inherent temporal event, invariant towards "history". Bela Bartok once transcribed Yugoslav folk music of gramophone recordings (both from aluminium disc or later from electromagnetic wire recorder) in the Milman Parry Collection at Harvard University[131] , thereby translating the physically real articulation into the symbolical regime which increases "information" in terms of order and selection, but looses additional information like the individual intonation, the temporal subtilities and the accidents, the "noise" as the authential trace of the unique performance event. We can listen even to the coughing when the *guslar*

127 As quoted in: Marcel Jousse, Le Style oral rythmique et mnémotechnique chez les Verbo-moteurs, in: Archives de Philosophie vol. II, Cahier IV: Études de Psychoogie Linguistique, Paris 1925, 10

128 Jousse, 17

129 See as well J. C. R. Licklider, Man-machine symbiosis, 1960

130 See Eivind Røssaak (Hg.), The Archive in Motion. New Conceptions of the Archive in Contemporary Thought and New Media Practices, Oslo (Novus) 2010

131 Bela Bartok, Parry Collection of Yugoslav Folk Music, New York (New York Times) 1942

(singer) Avdo Medjedovic starts to perform in one of the recordings.[132] Such coffing is phonographically registered as the interruption of the symbolic melodic order by the corpo/real - a memory which no alphabetic transcript or musical score can actually catch. Since the age of technical reproducibility of movement and sound, cultural memory has been liberated from restrictions to symbolical notation which leaves us with a bifurcated memory: the symbolical and the real. The coffing which interrupts the singer's performance actually corresponds with the cracks in the recording medium itself. Provided that there is still a player, the recordings can be originally replayed and decoded in completely new, variable ways. The acoustic event can be measured by oscillographical visualisation or spectral, techno-mathematical, non-cultural analysis.

In the Avdo Medjedovic movie - one of the first uses of sound film for ethno-musicological documentation indeed -, at 1:20 min. the sound recording abruptly ends in the middle of a verse line ("Ni bih ..." / "Nor would I ..."), while the sound of the recording rotating disc takes over rythmically: Now the medium speaks. A few seconds later (1:37), the visual filming abruptly breaks down as well. With that rupture, the real of the medium is at work, and physically breaks into the symbolic cultural scene. But with human watching or listening to such a record, an anthopological mis-reading happens: the tendency to forget about the recording apparatus, in favour of concentrating on the body and voice of the singer, looking at him as if he was still alive, being touched by his performance which is in fact nothing but a technological re-play.

Media archaeology contrasts this emotional affect by focussing on such a recording as a technological event, reminding constantly that there is no human voice but a machinic voice, in the sense of the transduction of body-based voices into a electronically reprocessed voice. The frequencies, even the timbre of the voice, miracolously, is still the same in both "media". The phonographic recording of Yugoslav *guslari* turns improvised oral poetry into a fixed inscription. But at second glance, the electromagnetic recording preserves a unique feature of the oral performance (different from its alphabetic, immobilizing transcription) which can be derived from how French language calls the recording device: *écriture magnétique*. Electromagnetic recording, by its very physical immateriality, only comes into existence as part of a dynamical process, the *inductive* act of re-play (writing different from printing). In his preface to Albert Lord's *The Singer of Tales* Harry Levin remarks: "The Word as spoken or sung, together with a visual image of the speaker or singer, has meanwhile been regaining its hold through electrical engineering."[133]

When around 1950, Parry's former assistant Lord returned to the scene to repeat some of Parry's first aluminium disc recordings with the same singers, in the meantime, technology had advanced: Lord used a magnetic recording device based on steel wire. The wire recorder is not a phonograph, which - as its very name still suggests - is part of the tradition of "writing" technologies; instead, the wire recorder registers sound in non-mechanical ways, in the

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132See and listen: `http://chs119.harvard.edu/mpc/gallery/avdo.html`

133 `Albert B. Lord, The Singer of Tales,` Boston (Harvard University Press) 1960, xiii

dynamics of the electromagnetic field. Electromagnetic recording and reproduction is not a continuation of writing in a new form, but a different existence of "memory". When a singer is replayed in electronic form in "high fidelity", the technology itself seems to efface itself in a way which apparently lets the originality and individuality of the singer shine through the apparatus, as dead as he might biologically be. The cultural, human aspect is being expressed in the most un-human medium; the circle of vibrations and frequencies in technology and poetry is complete. Thus the coldest media archaeological device is the best way to memorize unique moments of human culture, such as oral poetry.

What oral poetry performs is actually close to the neurological mechanism of memory, assisted by the hexametric verse as mnemo-technique, combined with the archive in Foucault's sense, i. e.: a generative grammar. Even the same singer does not repeat the same epic when performed (time-shifted) next time. In "re-generation", the prefix "re-" refers to memory, and the "generative" refers to *l'archive*.

[Reenacting radio]

It is possible to *operatively* replicate and thus equiprimordially revive Ferdinand Braun's nineteenth-century crystal radio receiver in the present indeed, using commercially available electronic components. One can still follow Braun's design principles today, even though they were established more than a hundred years ago and engineering is now many developmental stages ahead.[134] In the moment of this radio reception, its history is itself sublated in the implementation of media. What is lost is not the techno-operative message but only the performative content of the radio medium. We know almost nothing about early radio culture in terms of its actual programs - at best fragmentary recordings by means of other media, such as optical sound tracks, wax discs, and audiotapes.

The performative (humanly produced) content of "radio" broadcasting from the past has been lost to large degrees. But McLuhan teaches to shift attention from the apparent semantic content of a medium to its true media-theatrical, operative message which is radio's technical articulation. To a certain degree, the infra-structure of radio technology (its apparatus, its broadcasting infra-structure) has remained intact over generations, in an almost time-invariant endurance. Its single electronic components like the vacuum tube have been techno- evolutionarily, but not functionally been replaced: by the transistor first, finally be semi-conductors in Integrated Circuits. Ancient radios equipped with electron tubes, like from the late 1930s, are in principle still ready to receive signals with a connection to electric currency and a sufficient antenna cable. Unlike an authentic medieval document in an archive that reports news from a by-gone era, however, these radios do not broadcast programs from the late 1930s. This era was stabile with regard to its technical infrastructure: a technological interval that on a principle level experienced no history, no transformation, but rather the persistence of Hertz's electro-magnetic laws of radio. This era only now comes to a close through the reallocation of

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134 Wolfgang Schreier, Die Entstehung der Funktechnik, Munich (Deutsches Museum) 1995, 33

international broadcast frequencies in favor of digital broadband.

[Analysis of hearing provides an example]

Inserting microelectrodes into the auditory nerve for recording the events creates a human-machine coupling in the cybernetical sense. When J. C. R. Licklider researched the essentials of what constitutes "hearing" in humans and animals (auditory analysis), he explicitly asked: "Is there, built into the auditory nervous system, a mechanism <...> that supplements the cochlear frequency analysis?"[135] His very use of terms stems rather from electronic engineering than from traditional physiology, thus dis-embodying the analysis of human hearing. But "the analytical properties of the ear cannot be explained entirely in terms of the mechanics of the cochlea."[136]

The acoustic experience of the computer as (physical) body

Gerard Alberts, reader in the history of mathematics and computer science at the University of Amsterdam, has researched on the sounds which emanated from computers in the archaic age 1950-1960, where loudspeakers were mounted not primarily to generate mathematics-based music compositions (like the ILIAC suite), but for auditory monitoring (audification / sonification) of a very program in execution - in the absence of visual monitors, there was a direct auditory interface to the computer body - an embodied approach *de corporis machinae*, reminding of the corpor(e)ality of calculations within the machine (different from simply symbolic mathematics), which is a core epistemological issue of media archaeology.[137]

Statement: A vote for disembodied studies of *implementations*

The media-archaeologically extended perspective liberates the term "embodiment" from its narrow restriction to organic human bodies (just as Deleuze / Guattari pointed attention to the "non-organic body") and concentrates on aspects where human and non-human forms of embodiment-in-action meet: mathematics, implemented in the physical (and organic) world, means being-in-time. The very term "implementation" tries to avoid the anthropocentric interpretation of *embodiment*. In a similar way, *instantiation* refers the idea that in order for a property to exist, it must be object or have a substance. This is not limited to human bodies; in computer science, the "instance" refers to any running process (and in object orientated languages specifically to an object as an instance of a class).

135 J. C. R. Licklider, Auditory Frequency Analysis, in: Colin Cherry (Hg.), Information Theory. Papers read at a Symposium on 'Information Theory' held at the Royal Institution, London, September 12th to 16th 1955, London (Butterworths Scientific Publications) 1956, 253-268 (254)
136 J. T. Allanson / I. C. Whitfield, The Cochlear Nucleus and its Relation to Theories of Hearing, in: Cherry (Hg.) 1956: 269- (269)
137 "Die Körperlichkeit des Rechnens", lecture on December 18, 2010, at Media Studies, Humboldt University, Berlin

On its functional level, the description of an operative system is a diagram. Operative diagrammatics is the physical *embodiment* of symbolic languages. A world of difference takes place when this diagram is embedded in physical matter; in computer science, *implementation* names the realization of a technical specification or algorithm *as a* program (that is: software).

OPERATIVE MEDIA (ART) PRESERVATION. Adopting to the techno-logical time regime

Preserving the signal: Media theory in support of media art preservation

Preservation of media art does not simply require care for the material endurance of the artefact any more. Preservation of time-based technologies itself must be processual, as an ongoing act of up-dating the analog or digital art work.[138] Still, a media-archaeological veto insists: To what degree does the hardware of so-called "born-digital" art matter?

That is the moment when conservation specialists ask for epistemological advice. It is the primary task of media theory to take philosophical care of technical terms like the "emulation" of early computational media art works by contemporary operating system. What seems evident on a practical level turns out to be a delicate challenge to the ethics of museum preservation. Media archaeology describes the techniques of cultural tradition and develops criteria for a philosophy of dealing with the tempor(e)alities of techno-logical agents. Any piece of media art is subject to time in its hardware embodiment (physical entropy), in its logical, almost time-invariant design (circuit diagrams and software codes), and in its actual time-critical processing. Any epistemology and aesthetics of media art preservation aks for the foundation of 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"[139]. 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. What constitutes the "original" in technological

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138 As has been expressed in a ground-breaking series of exhibitions, symposia and the resulting publication by the Karlsruhe Center for Art and Media Technology (ZKM): Bernhard Serexhe (ed.), Konservierung digitaler Kunst: Theorie und Praxis. Das Projekt digital art conservation, Karlsruhe (ZKM) / Vienna (AMBRA) 2013; esp. Jussi Parikka, Maschinenkonservierung - Datenhauerei und die Zeitlichkeit technischer Zeit, 262-275

139 Doron Swade, Collecting Software: Preserving Information in an Object-Centred Culture, in: History and Computing Vol. 4 No 3 (1992), 206-210 (209)

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"[140] - 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 games from Datassette to 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.[141]

Museological media arts preservation might therefore be metonymic in terms of cultural heritage: taken as partial examplification as case studies to ensure future insight into its technological ground, a testimony of a specific techno-cultural epoque. In terms of McLuhan's media theory, preserving artistic content should reveal its underlying technological message which is its true potential "historical significance"[142]. 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 hidden knowledge of electronics and algorithms. "Als Medienträger sind für uns sowohl die Leinwand als auch die Medienapparate niemals zugänglich."[143]

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"[144], 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

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140 Swade 1992: 208

141 See Christian Sichau, Die Replikationsmethode: Zur Rekonstruktion historischer Experimente, in: P. Heering / F. Rieß / C. Sichau (eds.), Im Labor der Physikgeschichte. Zur Untersuchung historischer Experimentalpraxis, Oldenburg (Bibliotheks- und Infomrationssystem der Universität Oldenburg) 2000, 10-23 (10, note 3)

142 https://rhizome.org/art/artbase, accessed March 20, 2017

143 Boris Groys, Unter Verdacht. Eine Phänomenologie der Medien, Carl Hanser Verlag 2000, 21

144 See the "Foreword" to the exhibition catalogue: History will repeat itself. Stragegies of Re-Enactment in contemporary (Media) Art and Performance, edited by Inke Arns / Gabriele Horn, Frankfurt/M. (Revolver) 2007, 6 f., and Inke Arns' conceptual introduction "History will repeat itself", ibid., 36-63

room. The "reconstructed" installation can only be called "media" art if the aesthetic message pedends on the electric action of a functionally equivalent apparatus with a voltage range from 15 to 450.[145]

Video: Rod Dickinson's re-enactment of the Stanley Milgram experiment, CCA Glasgow, 2002: http://www.roddickinson.net/pages/milgram/project-milgram-video.php

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 *in being* as "media" only in the moment of signal processing, and media "art" is defined by its time-based modality rather than space-based sculpture and painting (Lessing 1766). Already in photography, the exposure time has been co-defining the iconology of the image - a *Delta t* which increasingly shrinked almost to zero.

Technological media are experienced in performative ways from the human side, but in operative ways from within. In museum display of media art based such as sound and video installations, "[t]he physical objects on display are not to be regarded as aesthetic objects per se [...]. *It is predominantly the process which is on exhibit*".[146] Whatever the aesthetic content may be (to be well documented by a conceptual text by the artist-creator himself), the message of "media art" is its time base and its active chrono-poetics.

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

Against the curatorial veto, infra-structural cables and circuitry in electronic art works - like the agorithms in digital works and the protocols of Internet art - belong to the functional, but not "ideal"[147] aesthetic enunciation, and therefore are allowed to be replaced for re-enactment. The aesthetic content of media art aks to be displayed in action to be revealed; otherwise a medium like a video set is nothing but a piece of metal, glass and rare earths.

Traditional works of art are subject to time in the material sense; it is their physical entropy which requires curatorship and restauration. A painting *endures* in time, different from media-art which unfolds in a different time

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145 Entry "The Milgram Re-enactment", in: Arns / Horn (eds.) 2007: 94 f.

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

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

singularity. A technological object, in addition, is time-based in a conditional sense; their "media" state only reveals when in operation, in signal-processing. The core requirement for the preservation of media art, therefore, is re-enactment, since its being only unfolds as a time-object. This message of media art (apart from the superficial audio or visual content) is temporal, therefore the focus of "preservation" is on actual re-enacment or documentation of its former temporal action, that is: the archival *time diagram*.

Media epistemology contemplates the *being-in-time* of technological art, and its archaeology grounds in precise technological inspection. There is knowledge to be gained from technical hardware. The media 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 re-generating and re-storing its signal processing. This approach is decidedly materialist and antinarrative in terms of social contexts. The conditions under which media arts from the past can be said to have 'presence' in the present"[148] are strictly techno-logical.

Operative media museology

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

[If the external (protective or decorative) case of a radio from the 1940s is removed, providing insight into the 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

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

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, then we miss their essence, but it is difficult for visitors to have a medium opened and understand what is going on within. It is a big challenge to museum education and didactics to explain what is really happening there, a challenge to the design-orientated, surface-orientated display.

As a consequence, the imperative for museological preservation of digital media art is to lay bare the underlying algorithms in a kind of techno-anatomy like artist Jan-Peter Sonntag's conceptual opening of media theorist Friedrich Kittler's electronic synthesizer modules, revealing the *arché* of the technological *archive* (in Foucault's, not in the bureaucratic sense), as claimed by Boris Groys: the "submedial space" behind the surface or interface.[149]

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

Materiality matters: electronic media art (esp. video)

Different from immobile museum objects in *stasis*, time-based technological artifacts are in their "media" (art) state only when being in dynamic operation. In order to functionally re-enact Dan Graham's video installation *Present - Continuous - Past(s)* (1974), the analog recorder tape delay may be emulated in digital signal processing. But the media-artistic message (the irritation of "presence") can only be preserved in its spefcific materiality which once triggered the idea of delayed presence, the reel-to-reel video tape and loop. Graham's installation has been a pure function of an electronic diagram: the *feedback circuit*, creating a re-entry within the actual present, as effect of technically delayed video tape signal transduction.

[See as well the score for Steve Reich's *Violin Phase* (composition 1967, published 1979): "Working with a four-channel tape recorder, the violinist and a sound engineer are given detailed directions for creating the basic tape loop that generates the performance tape used in live performance. And yet – no doubt due to the scarcity of appropriate tape recorders – most present-day performers of Violin Phase use looping hardware or software that make it possible to dispense with many of the instructions in the score, including the necessity of having the engineer on stage. [...] the decades-long ubiquity of tape has been replaced by a kind of invisibility, through which the particularities of the medium have been subsumed into more generalized notions of fixed media. [...] the specific materialities of tape and tape machines

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149 Boris Groys, Unter Verdacht, xxx, 21

are not incidental to Violin Phase, but are central to its composition, performance, and reception."[150]]

Synchronizing signals are recorded on a video tape itself, along with picture and sound information. This sync information enables the images to be played back in a stable fashion, oriented properly both vertically and horizontally. Changes in these synchronizing or timing signals cause time base errors that result in disturbances to the images, to be matched by the Time Base Corrector (TBC). Video itself takes place not simply in cultural time but is always already a technological time object itself, chrono-poetically manipulated by artists.

Video art *master* tape restauration means bringing it into playable condition again, which requires preservation of its signal processing state. This is technical rest*aura*tion, restoring its post-Benjaminesque "aura" by preserving its processual temp*aura*lity. Such technical reproduction of electronic signals basically preserves its processual authenticity, even when resulting in linear distortions of the signal.

A media art work is "copied" when resting within the same format; moving it onto a different format (analog transfer or digital "migration") means its transformation of substance.

It has been not with photography or film but with video art that "media art" as category emerged; 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 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).]

Nam June 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: *Participation TV* . 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, f. e. Nam June Paik's seminal installation *Participation TV*.[151]

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150 Joseph Auner, Reich on Tape: The Performance of Violin Phase, in: Twentieth-Century Music 14/1 (2017), special issue *Tape: Or, Rewinding the Phonographic Regime*, eds. Andrea F. Bohlman and Peter McMurray, 77–92, here: 77, abstract. The same argument holds for the 2012 "New realization" (German "Neurealisation") of Peter Weibel's sound sculpture ("Tonskulptur") *ichmasse / masseich* (1977/78) at ZKM Karlsruhe, based on a magnetic tape loop recurring between three magnetophones repeating the workd "I" ("Ich"); see Romana Schuler (ed.), Peter Weibel. Bildwelten 1982-1996, 69

151 See http://www.youtube.com/watch?v=JHC1CdgfkVo

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 film, is rather dematerialized and rather transmission (live signal) than representation (like the traditional museum painting), the criterium for such media art preservation shifts: from emphasis on materiality to 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.[152] If the material carrier remains transitory, only artistic content becomes the object of preservation. But McLuhan himself insisted, partly in accordance with the communication engineering model, that noise was part of the communication process, pointing at the hidden ground of the apparent technical figure. "What they [Shannon / Weaver] call "noise", I call the *medium* - that is, all the side-effects, all the unintended patterns and changes. [...] all media tend to be subliminal in their structures [...]."[153] But here McLuhan might have expressed more accurately (in comparison to Shannon): the medium *has* a (hidden) message.

Media archaeology does not bury techno-logical eventality by con-textualizing it in art historical narratives but helps for media devices to let it "speak for itself". Such enunciative media archaeography focuses on essential, knowledgable (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

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152 Ray Edmondson, AV archiving philosophy - the technical dimension, in: Proceedings of the IAMI-IASA Joint Anjual Conference, Perugia 1996, xxx no. 8 (November 1996), 28-35
153 National Archives (Canada), H. M. McLuhan Papers, H. M. McLuhan to Jerry Agel, 26 March 1976

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 analogue media enters the space of the calculating media by means of the simulation, for example, of a magnet tape video installation as a time event in a computer. The sampling theoreme allows for the digital to re-create the analog signal.

Media-active archaeology is time-reversed, such as the restored wonders 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"[154] by means of algorithmic signal detection and filtering software. An ironic echo is the *Vinyl/Video* project, which Gerhard Sengmüller calls a "piece of faked media archaeology"[155].

Un/intended video noise

A challenge of early video art hermeneutics is intentional "noise" as critique of contemporary television culture, as applied e. g. by Jean Otth in his *TV-perturbations* from 1972[156]; in museological preservation, it becomes incerasingly difficult to separate this intentional noise from unintended noise resulting from the preservation of early video art works = See Shannon; cryptography of the medium itself. In the time-critial realm, there is jitter or time base errors, mechanically resulting from delay in tape speed either already in recording (then irreversible), or by later hardware deterioration = Compendium 2012: 66. Dropout appears on the picture as small white spots or streaks. It can be internally caused by physical deterioration of the tape itself, or by external contamination of the tape with dirt or dust. It results in signal loss because the heads that read and display the picture information become clogged or dirty.

Physical damage to either the upper or lower edges of the tape results in playback problems. The upper edge contains audio information; the bottom edge contains control track information.

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154 McLean 1998, http://www.tvdawn.com/index.htm; accessed 15 March, 2008

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

156 See Kompendium der Bildstörungen beim analogen Video / Compendium of Image Errors in Analogue Video, in: Johannes Gfeller / Agathe Jarzyk / Joanna Phillips, Zürich (Scheidegger & Spiess) 2012, 150 ff.

If the chroma level is too low, the colors look faded. If the chroma level is too high the colors are overly saturated. If there is noise in the area of the tape which contains the color information, the colors appear to be moving inappropriately.

In electronic imagery, beam and focus of the cathode ray and its bias (voltage) "haben einen entscheidenden Einfluss auf die Charakteristik des Bildes - sie bestimmen sozusagen die Materialität, die es auf dem Weg in die digitale Zukunft unbedingt zu erinnern und zu konservieren gilt"[157]. With digital culture, there is a growing disteance to the aesthetics of the analogue, which becomes a knowledge matter in itself, a surplus of analogue video preservation.

For preservation, reconstruction and re-enactment of closed-circuit installations based on CRT cameras, solid knowledge of such electronic assemblages is a *conditio sine qua non*.[158]

Sustaining images from signals and as data

The Electronic Records Program at the National Archvies 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.[159] Kirschenbaum analytically separates forensic (hardware) and formal (software) materiality while admitting its increasing interlacing.[160] 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 quality being here and now (Walter Benjamin), it is dependent on its material presence which is lost in reproduction and differs from the ephemeral presence of the electronic signal. "[D]ie Aura ist an sein Hier und jetzt gebunden. Es gibt kein Abbild von ihr."[161]

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157 Gfeller, Videotechnische Grundlagen, in: Compendium 2012, 116- (117)
158 Gfeller ibid., 117
159 Kenneth Thibodeau, Overview of Technological Approaches to Digital Preservation and Challenges in the Coming Years, in: The State of Digital Preservation. An International Perspective, Concil on Library and Information Resourses, pub107 (2002),
http://www.clir.org/pubs/reports/pub107/thibodeau.html; quoted here from: Kirschenbaum 2008: 3
160 Kirschenbaum 2008: 111
161 Walter Benjamin, Das Kunstwerk im Zeitalter seiner technischen Reproduzierbarkeit [*1936], Frankfurt/M. (Suhrkamp) 1969, 14

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

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

[The Videodisc - technological scene (or condition) of a couple of 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 in data blocks.[162]]

With digital preservation of analog media art heritage, the data file becomes a complete substitute of the original image relating to the visual content.[163] 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 pixeling the visual information and translating it into the available 128 characters. Different art projects refer to this digital Stone Age like *ascii Vision* in the works of the *ascii-art-ensemble*.[164]

The media archaeological approach to preservation of (digital) media art preserves the conditions of possiblity of such aesthetic expressions, not primarily 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.

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162 See James Monaco, Film verstehen. Kunst, Technik, Sprache, Geschichte und Theorie des Films und der Medien. Mit einer Einführung in Multimedia, Reinbek b. Hamburg (Rowohlt) 1995 [EO: How to read a film, Oxford 1977], 465 ff.
163 Gschwind 2006 185 ff. "The Potential of the Digital Code", here: 187
164 visomat inc., asciiVision, in: Thomas Y. Levin, Ursula Frohne / Peter Weibel (eds.), CTRL[SPACE]. Rhetorics of Surveillance from Bentham to Big Brother, Cambridge, Mass. (MIT) / Karlsruhe (ZKM) 2002, 372

[There have been moments when the hidden technological ground expresses itself, like in the Williams-Kilburn Cathode Ray Tube memory in early electronic computing. 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 TV. 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.[165] The actual observer, here, is the computer itself.]

In early computing technology from 1947, the Cathode Ray Tube was actually used as a storage device for a number of bits itself - 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 itself.[166]

[The task of long-term preservation of technological artefacts aims at communication with a future audience, an intelligence which might not be necessarily "human" any more. "A robot historian would write a different history than would its human counterpart"[167], and Norbert Wiener adds in reverse hat a message need not be the result of a conscious human effort for the transmission of an idea; "the record of the thickness of a roll of paper kept by a condenser working an automatic stop on a [...] machine is also a message [...]."[168]]

[As expressed in an online resource for the preservation and legacy of (signal-)time-based (analoge) and new media (computational) works of art, in order to create a secure storage environment for media-artistic data, in digital preservation, this is achieved by generating checksums for your files which are monitored by re-checking, on a regular basis. The file is run through a certain algorithm (the most commonly used algorithms are MD5 and SHA) that produces a unique alphanumeric sequence. The slightest change to your file will produce a completely different checksum. With this simple process, it is possible to identify any changes to your files. The types of changes which can be identified with this method are those which indicate corruption, loss of data, or unintended manipulation. If you have an automatic monitoring system in place, it would alert you if such a change occurs. Calculate checksums as soon as you've received or created a file. 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."[169]]

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165 R. B. E. Napper, in: Rojas / Hashagen (eds.) 2000: 366; Fig. 1
166 See David Link, There Must Be an Angel. On the Beginnings of the Arithmetics of Rays, in: Siegfried Zielinski / ders. (Hg.), Variantology 2. On Deep Time Relations of Arts, Sciences and Technologies, Köln (Walther König) 2006, 15-42
167 Manuel de Landa, War in the Age of Intelligent Machines, New York (Zone Books) 1991, 3
168 Wiener 1942 3 f.
169 http://mattersinmediaart.org/sustaining-your-collection.html (www.tate.org.uk/about/projects/matters-media-art = Tate (ed.), Matters in Media Art

The "two bodies" of computer-based art

Different from previous technologies, the computer as *turingmachine* is a theory-born medium. Still, a symbolical machine (equalling the algorithm, according to Turing 1936), 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."[170] 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.[171] A UTM can emulate any other specific Turing machine, by defining its sets of program states and writing it as data symbols on the tape. "The Universal Turing Machine is remarkably similar to the Von Neumann model of a computer, where both programs and data can be stored on the same medium. [...] it follows that a UTM could emulate itself."[172]

[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. So we are 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 matahistorical realm of techno-mathematical logic) becomes "high fidelity"

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170 As quoted in: Paul Brown, Charlie Gere, Nicholas Lambert, and Catherine Mason (eds.), White Heat Cold Logic: British Computer Art 1960 - 1980, Cambridge, MA (MIT Press) 20xx, 86

171 Alan M. Turing, On Computable Numbers, with an Application to the Entscheidungsproblem, in: Proceedings of the London Mathematical Society (2) vol. 42 (1936), chap. 6

172 Mike DeHaan, The Universal Turing Machine is a Turing Machine Emulator [2012]; https://www.decodedscience.org/what-is-universal-turing-machine/12081 accessed February 9, 2017

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.

The different quality of computational media art

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 digital works of 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.

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

With computational art, though, previous media art differences are not rooted in their brute materialities any more but have become formats within the software regime. Source code on the one hand (algorithms), and the formating frameworks (operation systems, browsers et al.) are the core "engine" of New Media art. From that derives the option of "emulation" for re-creating (rather than passively archiving) a work of code art even if its original software environment has become obsolete. 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 less *art* specific but makes it a metonymy of the challenge in media-cultural heritage itself. Discussions on media art preservation should proudly claim this general relevance, beyond the museological case-studies in the more limited sense. Media art is evaluated on the basis of its technical properties which subject it to temporal ageing. But with digital media, there is an additional logical level of techno/logies involved which is neg-entropic 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 qualities of new media art are neither reducible to material nor to its software tools. Rather, new media art is process-based practice with limited duration, including artistic research. Documenting dynamic media art (be it site-specific installations or internet art) is one task; preserving and re-enacting the interactive experience another for which the "webrecorder" provided by Rhizome (New York) as free software allows. A gap opens between the phenomenal appeal and its intra-structural technical condition. Taking into account audience participation and (web-)site-specificity, it becomes clear that for processual media art works there is no such original state at any given moment from the phenomenological perspective. The technological conditions for such interactivity itself, though, on the contrary, are not allowed to change within the artwork from moment to moment, even if *in-situ* conditions mean that the installation must constantly adapt to new circumstances.

The challenge of algorithmic art preservation may be compared with 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 embedded within the machines, which is revealed by a specific work of media art, as process-oriented ontology. Terms like "emulation" are not just functional in the context of media art preseration but deserve unfolding their epitsemic delicacy in terms of object-oriented ontology.

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 "streaming media" is the algorithms and micro-processing electronic units which run digital media formats and compression - the real *archive* as pre-condition of media art action in terms of Foucault's *Archaeology of Knowledge*. A radical museological strategy aims at revealing computing architecture from within instead of surface display.[173] 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 developed in documentary science[174] therefore extends to the media-active "archaeo-logical preservation" of a continuously re-presencable

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173 See W. E., Towards a Museology of Algorithmic Architectures from Within", forthcoming in: When Is the Digital in Architecture?, ed. by Canadian Center for Architecture, Sternberg Press 2016 (English / French)

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

techno-aesthetic past.

MACHINICALLY INFORMED MUSIC FROM THE PAST: Human performer vs. operational re-enactment (analog, digital)

While many performers consciously seek to understand and recreate historical music as practice, still, not all musical practice which is from the past is necessarily historical: when the recorder and performer is not human but a machine such as the Welte-Mignon player piano rolls. From a techn(-*arche*)ological perspective, nonhuman piano play is not performative but operative; hermeneutic and re-interpretative human understanding of past music is replaced by *understanding media*. Even if any musical composition inherited from the past is irreducibly marked by "cultural, aesthetic, ethical, and even practical complications" (draft), there is no historical distance separating it from present re-enactment from the point of view of the functional machine enactment. Once the musician has been coupled to a recording machine, the record becomes neg-entropically timeless (in principle, set aside material obsolescence). The strategy of "emulation" (as has been developed to re-play vintage video games in retro-computing) may be evaluated a new epistemologic category for machinic music memory.

"Challenging histories" vs. "escaping history"

When artistic research deals with past musical practices, many performer-scholars consciously seek to recreate it. What actually has passed, is the unique acoustic embodiment of a musical composition in performative human variances, and the tuning of ears by musical theory. But musically (in terms of composition), there is no "historical" past at all. Günther Stern inquired the relation between music and historical time as expressed in his hablitation thesis *Die musikalische Situation* (which has been submitted in 1929/30 but rejected by Theodor W. Adorno). When listening to music "one falls out of the world"; nonetheless, "even in this hiatus, one remains in the medium of time".[175] There is an a-historic *momentum* of experiencing time in listening to music (the aesthetic affect) and in experiencing presence-generating devices (chrono-phenomenological *aisthesis*): "Musikalische Zeit ist nicht geschichtliche."[176] Listening to music is a non-historic form of being-in-time.

Humans, once actively coupled to a technical music instrument, are subject to its temporal *Eigenwelt*. Such a scene where humans and machines meet, in cybernetic terms, is a system.

Genuine sonic media theater, though, is a further escalation. A past musical performance is usually associated with the human performer. But there are musical performances which are rather operative for not bodily but machinic implementation. While a theatrical drama (time-ordered action) from the past

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175 Stern 1930, as quoted (in English translation) in: Veit Erlmann, Reason and Resonance. A History of Modern Aurality, New York (Zone Books) 2010, 325
176 Günther Stern, Typescript *Die musikalische Situation*, State Library Vienna, 1930/31, 46; now edited by xxx Ellensohn: xxx

can be re-enacted by humans (which is always individual performative re-interpretation), music machines do not re-interpret but re-operate, in equiprimordial repetition of the musical (symbiolic) or sound (signal) event. This is, then, no historical quotation or re-call, but a time-shift of the same class of sonic event.

Undoing musical historicity: phonographic signal "re-presencing"

There have been two ways to deliver music from the present to future: capturing the sonic signal by phonography (the analog way), and processing the musical symbol by discrete, that is in priciple: mechanizable notation (the "digital" way).

For the larger part of past musical activities, obviously there is a necessity of "historicizing", that is: indirect, contextual reconstruction of the past sound event, where technical (mechanic or electronic) recording and / or re-enactment is missing. In Villiers d'Isle-Adam's novel *L'Éve future* from 1880, regret is expressed for all the sounds which have been lost for posterity in the pre-phonographic era. The inventor of the phonograph, Thomas Alva Edison, laments: "Voici tantôt soixante-douze siècles <...> qui, d'ailleurs, à titre de précédent immémorial, controuvée ou non, eût échappé à toute phonographie."[177] The technical recordability of the physically real of sound and images suspends the clear-cut difference between presence and absence.

In order to convince the audience of the sonic fidelity of phonographic recording, the Edison Company in 1916 arranged for an experimental setting in the New York Carnegie Hall: "Alone on the vast stage there stood a mahagony phonograph <...>. In the midst of the hushed silence a white-gloved man emerged from the mysterious region behind the draperies, solemnly placed a record in the gaping mouth of the machine, wound it up and vanished. Then Mme. Rappold stepped forward, and leaning one arm affectionately on the phonograph began to sing an air from "Tosca." The phonograph also began to sing "Vissi d' Arte, Vissi d'Amore" at the top of its mechanical lungs, with exactly the same accent and intonation, even stopping to take a breath in unison with the prima donna. Occasionally the singer would stop and the phonograph carried on the air alone. When the mechanical voice ended Mme. Rappold sang. The fascination for the audience lay in guessing whether Mme. Rappold or the phonograph was at work, or whether they were singing together.[178]

[A similar staging of human vocal performance *versus* apparative acoustic operativity has been commented by the *Boston Journal* in the same year: "It was actually impossible to distinguish the singer's living voice from its re-creation in the instrument"[179] - . What takes place is the chrono-Sirenism of *His*

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177 Villiers d'Isle-Adam, L'Éve future, xxx 1880/1979: 34
178 "Edison Snares Soul of Music", in: New York Tribune v. 29. April 1916, 3
179 Quoted after: Emely A. Thompson, Machines, Music, and the Quest for Fidelity. Marketing the Edison Phonograph in America 1877-1925, in: The Musical Quartely Bd. 79 (1995), 132. See Peter Wicke, Das Sonische in der Musik, in: Das Sonische. Sounds zwischen Akustik und Ästhetik, in: PopScriptum 10 (2008), *online* http://www2.hu-

master´s voice, which is the presence-generating "illusion of being present" (Peter Wicke), even if induced by technical recording.]

Sound-automatic invariance: Baroque music machines

The alternative to phonographical recording of the actual sound signal has been the "musical", that is the literally symbolic approach. Media-archaeologically this goes back to a primary scene (*Urszene*), the moment when an ancient Greek adaptor of the Phenician alphabet explicitly made use of the letters A, E, I, O, U for the symbolic notation of vowels, in order to capture the musicality of Homer's oral poetry for tradition beyond the poet's grave.[180]

By using coded symbols to caputure not the sonic signal but its information, any musical score comes close to computer programming. Here, the algorithmic *is* the machinic, already (Turing 1936).

In the Baroque epistemology, there has been a "Cartesian" fascination with the animal as machine[181]; Robert Fludd designed a musical automaton in the absence of humans, different from Wolfgang von Kempelen's subsequent chess playing automaton which has been criticized by Walter Benjamin for having included a hidden human dwarf.

Musical automata are material reifications of musical compositions. Music from the Baroque era (Purcell, Händel, Bach) encorporates and intonates another temporality which differs from linear historicity. Boroque music, when performed in the present, generates a co-originary aesthetic presence. The reason is the mathematical, that is: *per definitionem* metahistoric algorithm of music composition, beating the time arrow by numerical operations (Newton and Leibniz' infinitesimal calculus) and therefore eqivalent to the musical automaton itself (Rainer Bayreuther).

A mechanical effort for micro-tonal inscription has been Nicola Vicentino's 1555 booklet *L'antica musica ridotta alla moderna prattica* where he proposes his "Archiorgano" which provides for 31 tone grades per Octave - an amazing, mechanically almost impossible short-cut to contemporary algorithmic realizations of micro-tonality. Research project Studio31 at Basel Academy of Music is actually (re-)building that diagram - active media archaeology.[182]

Such a text like Vicentino's asks to be deciphered not primarily as a document in (and for) the history of science or ideas, but rather immediately as a diagram of a constellation which is radically ahistorical, since it belongs to the class of subliminal sound analysis which is being performed nowadays with computer

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berlin.de/fpm/popscrip/themen/pst10/index.htm

180 See Barry Powell, Homer and the Origin of the Alphabet, 2000; further W. E. / Friedrich Kittler (eds.), Die Geburt des Alphabets aus dem Geist der Poesie, Munich (Fink) 2007
181 See e. g. Salomon de Caus, *Les Raisons des forces mouvantes* (1615)
182 See www.projektstudio31.com

software like Skyline for the graphical presentation of "tempo" on the real time axis.

Machine music is not only technical in the material sense but rooted in the close interrelation between music & mathematics in occidental sound culture; this makes it probable that the "mathematical" enunciation can be authentically re-enacted such as Johann Sebastian Bach's "well-tempered piano"; Henry Cowell, in his *New Musical Resources* (1930), actually recommends the Player Piano for the realization of Bach's structual music.

The *Kunst der Fuge* escapes - as expressed in its very name - the temporal flow, operating rather with stationary, that is: history-invariant sequences. Therefore mechanic instruments are not historic documents but media-archaeological monuments (leaving aside its physical entropic decay).

The machine renders music to our ears just as it has been doing to the ears of listeners in by-gone days, since there is no recording medium inbetween but an immediate re-production of the musical event. Being digital *avant la lettre*, it renders itself natural to *online* re-enactment.[183]

[Sound emanating from a musical automaton is no recording of acoustic signals but "originäre Klänge eines Musikinstruments"; therefore, in contemporary so-called historic performance practice, such apparatuses are unique. While for human-instrument coupling there can only be an approximation towards the authentic musical situation in the past, "repräsentieren die mechanischen Musikinstrumente als einzige Quelle eine authentische Wiedergabe"[184].]

A machanism for sonic time travelling: the piano roll

There is an explicit media-archaeological answer to the question how informed is "historically-informed performance". Player piano rolls have been machinically "in-formed", physically invasive. Punching is violent, not simply a symbolic material trace like score notation. With the "inscription" of a recording medium, the paper roll; graphical notation becomes "mechanical". Human "interpretation" intervenes not by the pianist in later times but already from sound engineers at the delicate moment when the "digitizing" puncher has to micro-interpret the rather analogue (secret of) recording graph. The function of the skilled human "editors" of piano rolls (encoding) has been to produce a dynamic code.[185] Media-archaeologically, the (secret) recording apparatus developed by Welte company for *recording* the dynamics of piano play for replay, correlates with contemporary technical devices developed for scientific *measuring* of micro-temporal piano key movements.[186]

183
    http://www.landesmuseum.de/website/Deutsch/Sammlungsausstellungen/Au
    ssenstellen_und_Zweigmuseen/Deutsches_Musikautomaten-
    Museum_Bruchsal/Musikautomaten-Galerie.htm (Zugriff 14. Dezember 2009)
184 Helmut Kowar, Mechanische Musik, Vienna (Vom Pasqualati Haus) 1996, 47
185 Reinhart 2005: 84
186 Such as the graphical registration developed by Alfred Binet and Jules
Courtier, Recherches graphiques sur la musique, in: L'Année Psychologique vol.

Sonic analytics

The dynamically faithful Welte recording of piano play corresponds with microtiming in the recomposition of past performance practice. Richard Beaudoin, since 2009, composes new, notated, acoustic works based on millisecond-faithful transcriptions of recorded piano performances, applying most refined methods of acoustic microscopy and microtiming.[187] Interpretation as sonic hermeneutics and as scientific measuring the acoustic event, all of the sudden, are no contradictions any more.[188]

"Western musical notation has been developed to represent [...] works that require performative interpretation."[189] But a spectrogram, e. g. of the first 21 seconds of Chopin's *opus* 28/4 in Martha Argerich's 1975 interpretation, created with the Lucerne Audio Recording Analyzer (LARA)[190], may be considered a sono-analytic "photograph" of the performance: "A spectrograph represents *sounds*, or vibrations in the air, but not *music*, which requires perception of a uniquely human sort [...] just as we see three-dimensional objects *in* certain two-dimensional arrangements of pigment."[191] Baudoin then manually transferred the spectrographic information into a symbolic score (*Latticed Window*).

For *continuous* Fourier analysis, a "perspective" diagram (suggesting three-dimensional unfolding of the signal) is appropriate, which provides insights for relatively harmonious spectra but not for sudden signal changes. Still, such a time diagram consist of a multitude of discrete points, like an escalation of the punched piano roll.

As has been expressed by Boris Yankovsky in his Syntonfilm Laboratory in Moscow, once sound has been spectrographically analyzed, it could be re-synthesized back, leading even to synthetic acoustics without human source at

2, Paris 1986, 201-222. See Wolfgang Auhagen, "In Search of Beauty in Music". Zur Geschichte der musikpsychologischen Interpretationsforschung, in: Loesch / Weinzierl (eds.) 2011: 15-26. For an exemplary case study, see Hermann Gottschewski, Die Interpretation als Kunstwerk. Musikalische Zeitgestaltung und ihre Analyse am Beispiel von Welte-Mignon-Klavieraufnahmen aus dem Jahre 1905, Laaber (Laaber) 1996

187 See Richard Beaudoin, The Principles of Microtiming and Musical Photorealism, manuscript http://nrs.harvard.edu/urn-3:HUL.InstRepos:3415685

188 See Heinz von Loesch / Stefan Weinzierl (Hg.), Gemessene Interpretation. Computergestützte Aufführungsanalyse im Kreuzverhör der Disziplinen, Mainz et al. (Schott) 2011

189 Baudoin / Kania: 123

190 See Beaudoin / Kania: 122, Fig. 4: output from the Luzern Audio Recording Analyzer (LARA), showing the millisecond-faithful measurement of four bars of Chopin Op. 28/4 in the recording of Martha Argerich from October 1975

191 Richard Beaudoin and Andrew Kania, A Musical Photograph?, in: The Journal of Aesthetics and Art Criticism, 115-127 (121)

all like the Vo(co)der; such graphical sound extends to manipulations like time-stretching and pitch transposition.[192]

In contrast to machinic reproduction, human piano play from a historic score is hermeneutizing the notation, just like in early ninteeth century, lithographic engraving endured as "critical" form of reproduction of historical paintings, rivalling the "new" medium of photography.[193]

A Chopin score "is not a transcription of a performance; it prescribes how certain performances [...] should be [...]. In this respect, it is more like the circuit diagram an engineer produces for a new electrical component [...]"[194] - diagramatic sonicity (as variance of Peirce's concept of "diagramatic iconicity").

Digital art preservation (which is not the musicological but the museological challenge for the tradition of contemporary media culture) knows the concept of "reinterpretation" for installations which can not be faithfully reenacted in its hard- and software and site-specific interaction. Its "historical" integrity can be approached only in discursive documentation and conversation with the original artist[195]. In contrast, a media-archeological re-interpretation aims at an operative, non-discursive, rather functional equivalent (called "emulation") of the artwork (infra-)structure, including its processual micro-timing.

While practice-based artistic research explicitly keeps the artist's perspective as the starting point for musical knowledge, media archaeology asks for a counter-balance, closer to the methods of exact science, analyzing media-induced phenomena on the level of their actual appearance, that is: enunciations in terms of Michel Foucault's *Archéologie du savoir* (1969), There are real (in the sense of indexial) traces of past sonic articulation, different from their indirect evidence symbolically expressed in literature, historical descriptions and musical notation.

In the case of technological storage, though, in mechanically fixed recording, re-activation at any later moment in time is possible, against all growing physically entropic obsolescence and historical or transcultural distance. There are limits to the philological reconstruction of past musical practice indeed, due to the scarcity and unreliability of ancient sources on music.[196] But unexpectedly, new tool for research on ancient *mousiké*: have arisen, enabling us to (re-)enact textually received mathematical arguments on music in the computing space, re-creating the ratios of sound and melodies by digital signal processing.[197]

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192 See Smirnov 2013: 209-226
193 See Segolen leMan, xxx
194 Beaudoin / Kania: 124
195 See entry "Reinterpretation" in the glossary of Serexhe (ed.) 2013: 638
196 See Hermann von Helmholtz, Die Lehre von den Tonempfindungen als physiologische Grundlage für die Theorie der Musik, Vieweg 1913, 444
197 See Martin Carlé, Geschenke der Musen im Streit ihrer Gehörigkeit. Die antike Musiknotation als Medium und Scheideweg der abendländischen Wissenschaft, in: Sebastian Klotz (ed.), xxx

Like a musical score notated for piano, an algorithm coded for computer needs to be instanciated in order to unfold as actual sonic event.[198] The individual "interpretation" by the human pianist, though, radically differs from what the nonhuman compiler or (literally) *interpreter* does in implementing digital code. While the concept of "historically informed" performance of music from the past understands information in respect to the historical contexts[199], in the case of nonhuman piano play even the dynamics and micro-temporalities of individual interpretation from score is coded into a Welte-Mignon roll.

[Even "analog" recording, by subsequently transforming the wave forms into numerical frequency values, can then be "digitally" calculated. With the arrival of the phonograph, cultural tradition has been enriched by sonic signal memory. But only the digitizing of such signals allows for its algorithmic analysis, creating an archive (symbolic order, turned into sequentially ordered binary symbols) for future re-enactment. A/D conversion ("sampling") of musical performance therefore is *futurum exactum* already and allows for retro-analysis of the actual signal event.]

By coded recording, the individual performance becomes "archival" information in the sense of communication engineering (Shannon). Its reproduction on a Player Piano actually *is* "informed", but not in a historical, but media-archaeological sense. The Welte-Mignon is no musical performance but a techno-musical operation (in the sense of Turing's equation of algorithm and machine).

[A player piano *alias* "Pianola", by definition, is a self-playing automaton; a pneumatic or electro-mechanical "mechanism that operates the piano action via pre-programmed music recorded on perforated paper, or in rare instances, metallic rolls, with more modern implementations using MIDI encoded music stored on floppy disks or CDs"[200]]

[Composer Beaudoin created a collection of works for solo cello, based, among others, on microtimings of Debussy's Welte-Mignon roll (called "Bacchante"), borrowing the book title *Digital Memory and the Archive* for one of his works. In the context of such cello music, the phrase "digital archive" includes the double meaning of digital, as relating to the fingers. Here the human-machine interface becomes decisive: the keyboard for discrete input.]

[Traditional musical notation for piano has been a "loose coupling" of discrete values which becomes a "tight form" (literally in-formed) only in the moment of individual interpretation by the performing pianist. While the composer (the "information source" in terms of communication engineering) has transduced his musical message by coding as score for "sending" it through the material channel of (cultural) transmission, beyond the technical "receiver" (decoding the score), the "information well" [*Nachrichtensenke*] is still a human

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198 Innocenti 2013: 242
199 See John Butt, Playing with History. The Historical Approach to Musical Performance, Cambridge (Cambridge UP) 2002
200 https://en.wikipedia.org/wiki/Player_piano, accessed 19th january, 2017: See as well Larry Givens, Re-Enacting the Artist. A story of the Ampico reproducing piano, 1970

interpreter again.[201] In a more precise theory of communication (Shannon), the receiver is, first of all, a technical device which finally renders the message to the human ears. If the coupling of punched paper roll and Player Piano becomes the "interpreter" (which in Charles S. Peirce's and Frider Nake's sense can be nonhuman like computational software), ambiguities are radically removed. From "allographic" (in Nelson Goodman's terms) musical composition, the machinic recording becomes "autographic".[202]]

Chrono-vibrational resonance: Experiencing the (Mono)chord

Media-temporality is experienced by operating the physical media themselves, such as the re-enactment of the experiments once conducted by Pythagoras. Pulling the string on the monochord enables to experience the harmonic, atemporal relationship between integer numbers and "musical" intervals. Like historiography, music (as conceptual, notational scheme) is symbolical ordering of "time"; temporality comes in only with the linear (analog) or sequential (digital) machine.

Even if the present is not in the same "historical" situation as a Pythagorean ancient Greek, and the current mode of listening must be considered to be very different, then the monochord is still a time machine, inviting to share, participate at the original discovery of musicological knowledge. This approach of re-enactment, close to the practice of experimental archaeology, gives access to the invariants of knowledge in time; the physical objects themselves function as technological time capsules or time machines. "Entering a time machine implies isolating an item from its context. Consequently, particulars can be made persistent, but not their total context or 'world'."[203]

[Resonance is a form of instanteneous communication and "allows things to respond to each other in a nonlinear fashion."[204] It is technologically well known within the electro-magnetic field (such as the communication between radio sender and radio receiver), extends to the techno-temporal relation between presence and past as well, which thereby ceases to be a historiographically

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201 See Perla Innocenti, Keeping the Bits Alive: Authentizität und Langlebigkeit für digitale Kunst, in: Bernhard Serexhe (ed.), Konservierung Digitaler Kunst / Digital Art Conservation: Preservation of Digital Art. Theory and Practice, Cologne (ZKM) 2013, 232-247 (243)
202 Innocenti 2013: 242, referring to Nelson Goodman, Languages of Art, Oxford / London (Oxford UP) 1969
203 René Munnik, Technology and the End of History. From Time Capsules to Time Machines, in: Liisa Janssen (ed.), The Art of Ethics in the Information Society, Amsterdam (Amsterdam UP) 2016, 106-109 (109, note 4, referring to: Heidegger, Sein und Zeit 2006: 372-404 (German orig. 1927, esp. passage "Altertümer im Museum"); see further Martin Heidegger, Ursprung des Kunstwerks (1936), and Hans-Georg Gadamer, Wahrheit und Methode, xxxHeidegger
204 Erik Davis, Acoustic Space, Riga 1997 = http://www.techgnosis.com/acoustic.html (xxx)

linear one.[205] „Being tuned" (Heidegger) in the present leads to a different kind of communication with the past as *implicit sonic* resonance.[206]]

In media time, the artefact emancipates from human-made "historical" context (as defined by Giambattista Vico); technology is rather rooted in a different "world" of technical and logical infrastructures. Such a redefinition of "context" allows for a non-historicist form of access to technical operations from the past : techno-hermeneutic, e. g. the "physical modelling" of conventional music instruments, and the "auralisation" of past concert halls by computational modelling, a media-active retro-mesauring and emulating (mapping) of room acoustics - archaeonautics of sound.[207]

Audio-technically induced (transduced) "archiving" of deferred presence

Different from emphatic cultural *memory*, techno(archeo)logy deals with intermediary storage.

In phonography, just the actual sound (the "pheno-text", with Kristeva) is continually recorded by the revolving storage medium, while the "digitally" punched roll in the Welte-Mignon player piano since 1904 automatically replays the geno-text as well: "the tempo, phrasing, dynamics and pedalling of a particular performance, and [...] the notes of the music, as was the case with other player pianos of the time"[208] - from recording to recoding. This recoding, once implemented on a mechanical instrument, allows for the co-original reproduction of the sound event - just like in current synthesizer technology (as could be noticed at the Super Booth fair in Berlin, April 2017) some beats result from a coupling of the electronic device triggering actual physical drums again instead of mere loudspeaker membrane rhythm. The Welte apparatus has been "post-digital" *avant la lettre*, interlacing both signal-sensitive (time / touch / dynamics) analog and digital (coded) sound recording.

[The contingent temporalisations of a muscial score by actual interpretation differ from the equi-distant clocking in electronic and digital audio-processing; the machine takes over the agency of micro-timing. "Hearing music, we oscillate with its metric wave."[209] Is there temporal in-formation by such pulsating sound? And is this metamorphosis algo-rithmically achieved?]

Genuine techno-musical recording allows for equiprimoridal reperformance, as has been defined for "acousmatic", that is: loudspeaker music' which "can be said to encompass all fixed media (in old parlance "tape") music, without live performers or other media, regardless of whether it is based on recorded or

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205 See Rupert Sheldrake, The Presence of the Past, xxx
206 On Heidegger's notion of „Gestimmtheit", see Erlmann 2010: 327, and
    Heidegger's lecture on logics (Logik-Vorlesung) 1934, 129 and 135
207 See Stefan Weinzierl, xxx
208 https://en.wikipedia.org/wiki/Welte-Mignon, accessed 19 January 2017
209 Victor Zuckerkandl, Sound and Symbol. Music and the External World,
    Princeton (Princeton U. P.) 1956, 204 f.

synthetic sounds"[210]. The electro-acoustic engineering gesture of "rewind" in reel-to-reel magnetic recording actually challenges the notion of temporal irreversibility for historic music performance, as (almost allegorically) expressed in Samuel Beckett's one-act drama *Krapp's Last Tape* (1959) where the main actor gets lost in the memory loops of his autobiographic tape recordings.[211]

["Historical ecologies", drawing on Bruno Latour's ANT, may be described as "a web of relations, an amalgamation of organic and inorganic, or biological and technological, elements that are interconnecting and mutually affecting"[212]]

Steve Reich's composition *Violin Phase* grew out of his realization of the human capacity for, as he wrote, "imitating machines". "While in his writings the word 'machines' sometimes evokes the broader category of any mechanical devices with repetitive motion, the tape machine is often the specific referent. Reich describes overcoming his initial fears that humans would be incapable of the gradual phase shifting process by discovering in 1966 that he could play along with a tape loop 'exactly as I were a second tape recorder'."[213]

The human piano informer of historical music is an individual "subject" as interpretative agency but "subject" to code, and becomes coupled inbetween symbol reading (score) and mechanical keys (Karsakov 1932), in a turingmachine like state, partly machinic.

[How close can a listener with Welte-Mignon come to original intentions of a past piano player - who had consciously devoted himself to the mechano-phonographic recording. Each individual roll, depending on the thickness of paper, for replay, necessary requires the readjustment of tempo (speed) in the pneumatic motor. The micro-temporal authenticity will stay fuzzy until an original recording apparatus will be re-discovered, for uncovering the techno-logics ofthe machine and thereby judge the recording with rather mechanic than hermeneutic certainty.]

[There is the piano keyboard in the field of discrete, coded music (and symbolically coded archival records), different from phonographic recording which can be re-played as signal.]

The notion of "historically *informed*" performance, in a precise sense of "information", is a function of the archive, that is: the symbolic code, be it alphabetic texts, musical scores, or now: numerical data values.

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210 Nick Collins, Margaret Schedel, and Scott Wilson, Electronic Music (Cambridge: Cambridge University Press, 2013), 125
211 See further the editorial of the "tape issue" of Twentieth Century Music (2017), eds. Bohlmann / McMurray)
212 Benjamin Piekut, 'Actor-Network in Music History: Clarifications and Critiques', Twentieth Century Music 11/2 (2014), 212
213 Joseph Auner, Reich on Tape: The Performance of Violin Phase, in: Twentieth-Century Music 14/1 (2017), 77–92 (80), referring to: Steve Reich, Writings on Music, 1965–2000, ed. Paul Hillier (Oxford: Oxford University Press, 2002), 24 and 22

Phono-graphical analysis vs. hermeneutic interpretation

The media-archaeological perspective on "historically informed performance" focuses on the operative interpretation by the machine itself. The muscial machine, in terms of Actor Network Theory, is a nonhuman agency, it co-interprets.

Rather than simple repetition of phonographic signal recording, the Welte-Mignon mechanism is about equi-primoridal re-production (*mimesis*), different from Walter Benjamin's critique of *Das Kunstwerk im Zeitalter seiner technischen Reproduzierbarkeit* 1936/37. George Antheil arranged Part I of his Ballet Mécanique for Welte-Mignon piano.

There is a whole culture of music automata, but the truly media-archaeological object of interest in the Melte-Mignon case is not the discrete player piano mechanism itself but its pre-condition: the analog recording mechanism which has been concealed and significantly disappeared.

The analysis of the player piano therefore starts with its techiques of recording. Mechanic and electronic recording devices catch acoustic signals more precisely than any symbolic score notation does. Just like the Edison phonograph in 1877 enabled not only speech reproduction but, in reverse, analytic access to the physically real audio event, the difference in piano play recording as well is between musical notation of piece for piano and actual sonic signal recording of piano playing with its unique "temp*aural*" individuality (to modify Benjamin); pressure and tempo in piano play, seen from techno-physical perspective, are time signals.

[The micro-temporal analysis as actual interpretation of a score by the piano performer has replaced the "philological" interpretation of the written score as *oeuvre* in Western music.]

This corresponds with the machine recording of piano play itself. The mechanism of the Welte recording for player piano has been kept secret by the company and mostly hidden to the actual performer, dissimulated in favor of the appearance of a traditional piano. Therefore it takes the most precise efforts of media archaeology to reveal the secret.[214] The piano as instrument, like the cembalo, had been a mechanism already, known to the performer, but a media act of a second order takes place with automatic recording. As with most technical muscial instruments, the interface hides the mechanism.

[From the evidence of a few surviving yet un-punched Welte piano rolls (for "correction"), it can media-forensically be concluded that the recording apparatus created proportional electro-chemical inscriptions of the dynamics of touch and tone from electro-mechanical contacts within a mercury tank; the ink graph was inscribed by rubber wheels on 100 tracks, induced by electric circuits, and then manually "transcribed" (actually "coded" in the sense of Hollerith machines) by human punchers into rolls. What still remains is time-critical incertitude, caused by the paper thickness and cylinder speed.]

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214 Reinhart 2005: 79

Only one recording apparatus for the parallel mechanism of the Welte-Philharmonic-Organ has survived (from the former recording studio of Welte company in New York), finally on display in the Swiss National Museum for Musical Automata at Seewen.

[Nikolay Bernstein's "chronocyclography" has been a parallel efforts for techno-analytically catching the musical "gesture".[215] Graphical analysis results in a spatialization of the sonic time axis; a geometrization of the sonic event, disenabling it of its essential message which is time, ultimately re-Pythagorizing the musical event into a mathematical ratio instead of its processual wave event.[216] But when coupled to a machine reading, graphical inscription becomes a musical time-event again.[217]]

A punched piano roll, though readable for eyes which got used to its punctuations, has never been "written" for human eyes, but for mechanical decoding - like the binary digits within a Turing machine for the read/write "head" (Turing 1936/37).

Recording technologies provided for a new criterium of artistic practice which is its micro-temporal aesthetics. Such information on the actual dynamics and minute tempo differences needs actual machine performance to become evident. Current motion-capturing of piano play for neuro-aesthetic analysis (Godoy) in fact provides the data for future "historically informed" re-performance; with the unbiquitous digital recording of musical action, the musical culture of the present already becomes a pre-emtive *futurum exactum*.

[One of the first audio-visual recordings in ethno-musicology is the sound "movie" of *guslar* Avdo Medjedovic's variance of oral poetry in the Milman Parry Archive of Oral Literature at Harvard University. Epical orality, fixed on phonographic media like the master recording of a Jazz improvisations, have almost immediately been transcribed for philological interpretation by the scholars (Milmar Parry, Albert Lord) and transcribed into a score for musical research by Bela Bartok in its time. By its parallel storage on aluminium disc, wire spool or sound film as signal memory, though, it can now be techno-mathematically be "transcribed" into a score of a different kind, serving "Digital" (or better: algorithmicized) Humanities research. A different kind of "transscription" of piano play dynamics not into a musical, but a "machine language" (almost Assembly-like) score, has been enacted by the human punchers in the Welte roll factories. While sound film recording remains external to the instrument-player (machine-body) system, the photo-electric

215 See Julia Kursell, Moscow Eye and Ear-Control. Über die neurophysiologischen Arbeiten von Nikolaj Bernsteijn zum Klavierspiel, in: Sabine Flach / Margarete Vöhringer (eds.), Ultravision. Zum Wissenschaftsverständnis der Agantgarde, Munich (Fink) 2010, 83-105
216 Hermann Gottschewski, Graphic Analysis of Recorded Interpretation, in: Computing in Musicology vol. 8, 1992, 93-96
217 See Binet / Courtier, Recherches graphiques sur la musique, in: Scientific American 22 (Febraury 1896), 16801-16802, supplement no. 1051; previously published in: *Revue Scientifique*

generation of sound from light waves from within an instrument (such as the Welte organ) is truly media music.[218]]

It has been the ambition of the Welte-Mignon automatic piano play recording to reproduce the actual individual performance of the interpreter of a score; the machine itself is the "interpretant" in Peirce's sense of *semiosis* (just like algorithms in computing, according to Frider Nake).

Discrete coding differs from graphical notation just like the difference between material reproduction (embodiment of the piano mechanism) and phonographical replay. The Welte-Mignon recording/replay mechanism as analog/digital hybrid allowed to capture both conditions necessary for techno-logical reproduction of an original musical piano player performance, as expressed in a booklet for use of american Welte-Mignon recording mechanism, published 1917. "Mit diesem wunderbaren Wiedergabegerät ausgestattet [...], wird die ursprüngliche Interpretation reproduziert, oder neu erschaffen, mit allen feinsten tonalen Schattierungen, Akzenten und Eigenheiten des Ausdrucks."[219]

Fig.: Reinhart 2005: 82, advertising on coding the roll, from Welte-Licensee catalogue 1924: section from an original recording of Chopin's Etude in F Major

"Every detail of the artist's playing is graphically recorded while he plays. With this absolutely authentic 'tone picture' [...] the record is not a mere approximation, but an exact reproduction of his playing. What may be called the 'film of the music camera' receives impressions of every detail of both his fingering and pedaling. The exact position of every note played is fixed by faint vertical lines corresponding in number to the keys on the piano" - like phonographic groove. "The staggered lines [...] are the means by which the mechanism, like the delicate needle of the sismograph that recordes the slightest tremor of the earth, graphically indicates exactly the degree of pressure with which the artist struck the keys, thus faithfully recording the finest shading of his interpretation."

Human senses can not cognitively integrate the machine its sees with what is hears: Lubka Kolessa, in 1928, plays Frédéric Chopin on Welte-Mignon: Mazurka No. 23 D-Dur Op. 33, 2

This leads to an increasing techno-trauma. Technical re-enactment instead of simply replaying the authentic performative momentum, miracolously under the conditions of digital media, is: the most in-human mechanism, resulting in an epistemological irritation of cultural semantics: the "original copy" (an oxymoronic term from contemporary copyright legislation).

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218 On the opto-acoustic ("optophonic") discs in Welte organs, see Peter Donhauser, Elektrische Klangmaschinen, Vienna - Cologne - Weimar (Böhlau) 2007

219 Mark Reinhart, Der Welte-Mignon Aufnahmevorgang in Deutschland, in: Gerhard Dangel (Red.), Aus Freiburg in die Welt. 100 Jahre Welte-Mignon: automatische Musikinstrumente, exhibition catalogue, ed. Stadt Freiburg, Augustinermuseum, Freiburg i. Br. 2005, 74-87 (79)

Music score publisher White-Smith raised a copyright law issue against player piano roll producer Apollo for issuing two of their works; the U.S. Supreme Court in 1908 though defined such rolls as integral part of the mechanism and therefore no copies of the artwork: "Even those skilled in the making of these rolls are unable to read them as musical compositions, as those in staff notations are read by the performer."[220]

In times of post-hermeneutic theory, the score is not the exclusive subject of musicological research any more; as well the real embodiment matters (both in terms of physical sound and the psycho-physical performer), its presence and event. Friedrich Nietzsche once defined aesthetics as "applied physiology". Today, this extends to applied cybernetics. With the machine capturing of past human "musical" physiology and cognition from analog to digital, not only scientific analysis, but technical re-synthesis is possible. Musical culture must first become completely inhuman by another cultural knowledge operation (the machine) in order to be unfolded again.

MICRO-DRAMATURGICAL TEMPORALITIES OF MEDIA THEATRE. On the difference between performative and operative reenactment in the performative arts and in the apparatus

Lasting signals, storage media remains

Next to the *performative*, body-based arts (ancient Greek *mousiké techné*), in human culture a parallel world of *operative*, machine-based arts (literally *techné*) has emerged, whose scene of appeareance is appropritely called "media theatre". Media theatre is not body-based theatre augmented by media technologies, but turns this perspective upside down:; media archaeology identifies the drama within the technological event itself.

Body-related *performative* arts differ from *operative* "media theatre" that dramatically unfolds *within* technologies and *inbetween* humans and machines. Media theatre is addressed both as operative *algorithmic reenactment* and media archaeological *reenactment of algorithms*.

Parallel to the long cultural tradition of performative arts with its temporal dialectics beween the ephemeral and the lasting, runs the transmission of technological remains (audiovisual archives as well as hard- and software itself). Both modes of inheritance converge in the option of "reeanctment", though in different ways.

The argument unfolds both in media-archaeological perspective (the manual, "hands-on" experimentation of time with machines), with the case studies of reenacting past radio and the technical recording of oral poetry, and in an effort to derive epistemological insights from such practice, such as the appeal of "presence" from "historical" media (e. g. the "anatomy" of Friedrich Kittler's modular sound synthesizer, and so-called "Historical Performance Practice" applied to electronic music). New practices of technological reenactment for digital objects emerge, reaching from sonic "ghosts" in MP3 compression up to

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220 As quoted in Samuels 2000

truely computer-archaeological *emulation* as new epistemic category generated in the epoque of digital culture.

The challenge ranges from analog instruments like the ancient monochord, electro-acoustics like the analog synthesizer, and computer-based music with its possible emulation. In recording technologies, the remains and the remaining of the transitory (signals) are both material (hardware) and immaterial (magnetic latency). If *techné* and *ars* are not limited to human scenic arts but extend to operative media as well, a new kind of techno-cultural memory arises: the apparent oxymoron of an "enduring ephemeral", in the name of information, undoing material historicity. Transcendence of materiality and material ephemerality is a cultural effort well known from religious performance. With photographic inscription and its *punctum* (Roland Barthes), light itself became a „historiograpical" index, media-phenomenologically even transcending history by its affect of immediacy on the human temporal sense: preserving the past as present. But still this is not really immaterial but bound to a chemical storage medium. *Temporal* transcendence of materiality is a faculty of operative media technologies only. Once the signals which are chemically fixed (photography), mechanically engraved (phonograph) or magnetically embedded (magnetophon, videotape) on material carrier have been transformed into digital, immaterial information, they can be virtually lossless „migrated" from one storage computing system to another. Permanence and archival endurance thus is not achieved in the traditional way any more (which has been monumental fixation, *stasis* so far), but by dynamic refreshing - the "enduring ephemeral"[221].

Manual experimentation of time with sonic machines

"Operativity" is essential for the definition of technical media. If the cultural and discursive knowledge of technology is not limited to illustrations in texts and books, to distant observation in museums and to pure documentation in archives, there is a need for platforms where technical objects can be operated "hands on" in their primary materiality. Let us draw here an analogy between musical instruments and electronical media since both are "time-based" in their essential function. A primary scene of "hands on media" has been the experimental use of the one-string instrument as measuring device - the ancient *monochord* with which the Pythagorean calculation of harmonic sound ratios once started. Different from the historicism of cultural time where the knowledge system of one epoque is clearly separated from its subsequent epoques, the same physics of the oscillating string of a monochord appealed to the inquisitive ear equiprimordially for Pythagoras in ancient Greece and for Marin Mersenne in the early modern period. Admittedly the discursive horizon of knowledge is actually different; depending on the historical index, things resonate differently in humans and yield different concepts. However, the medium event is always one and the same; it constantly induces scientific or aesthetic curiosities, through which humans respond to technological relations

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

in new variations.

Is cultural tradition diachronic by necessity?[222] Technological devices, as tight couplings and configurations of material knowledge, keep an inherent functional "system" memory which can be reactivated each time it is set in operation again. The monochord in fact allows for a sonic time-tunneling by short-cutting the apparent cultural-historical distance which separates the present from antiquity. If we consider the monochord as an operative medium, it becomes a way to demonstrate an alternative approach to get in touch with media-implicit knowledge from the past. The mathematical principles of even such simple techniques enable a tight coupling between the present and antiquity, establishing an operative circuitry. Whenever we lay hands on the monochord, we share at least a bit of that past knowledge that is actually not past when it sounds.[223] The best method to understand a medium is by its reengineering and its functional reenactment. Charles Sanders Peirce describes such *diagrammatic reasoning*: "Similar experiments performed upon any diagram constructed to the same precept would have the same result."[224] Thereby we share Pythagoras' sono-mathematical experience by operating the monochord with our hands today. Collingwood equally reminds of the endurance of Pythagoras' geometric discovery concerning the square on the hypotenuse. It is just that the present mind must be somewhat *tuned* in the right cognitive mood.[225] We are certainly not in the same historical, that is: contextual situation like Pythagoras, since the ways of listening and the psycho-physical tuning are different. But with our audio-tactile organs (ears and fingers) "on" the monochord, we experience a time-machine in a different sense: It lets us co-originarily participate at the discovery of musicolgical knowledge. As has been argued in Martin Heidegger's *Time and Being* (and later resumed in Jacques Derrida's *Grammatology*), the repeatable *is* the original.[226]

Flexible access to the audio-visual past

For apparently antiquated technologies, media-philological understanding requires an actual reenactment *of* and *by* the actual medium. If the essence of technical media lies in their implementation, then they are radically committed to operative temporality. The classical archaeological and historical method conceives of both intentionally and unintentionally recorded sources as

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222See John Miles Foley, Traditional Oral Epic. The Odyssey, Beowulf, and the Serbo-Croatian Return Song, Berkeley / Los Angeles / Oxford (University of California Press) 1990, 3

223See Vivian Sobchak, Afterword: Media Archaeology and Re-presencing the Past, in: Huhtamo / Parikka (eds.) 2011: 323–33

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

225 R. G. Collingwood, The Idea of History [*1946], rev. ed. Oxford et al. (Oxford University Press) 1993, 217f.

226Martin Heidegger, Sein und Zeit [1927], 16th edition, Tübingen (Niemeyer) 1986, 385: "Die Wiederholung ist die ausdrückliche Überlieferung, das heißt der Rückgang in die Möglichkeiten des dagewesenen Daseins."

tradition, including written sources, material remains, and abstract remains (institutions, infrastructures, etc.). But with the invention of modern technologies of recording events as signals, such as photography, film, and tape recordings, a new kind of remains is constituted: the age of non-symbolic technical reproducibility. This is where active archaeological reenactment comes literally into play, operated by technologies themselves, as genuine media theatre.

The "archival" challenge does not simply refer to the archives in its institutional sense of memory agencies, but to the epistmeological notion of *archive* as expressed by Foucault: Which rules govern what can be expressed and remembered (that is: stored) at all? It not only human archivists any more, but in a higher degree than ever it is technologies on which the readability of such documents rely. The archival record has become an electromagnetic latency. Dynamic access needs a flexible tool which allows for the coexistence of different orders without destroying the structure (database). From the question of how to archivize performance results the performative archiv: forms of reenactment. Not only the target, but as well the very temporal modality of the archive has been extended. The answer lies in discovering and reflecting upon (and techno-mathematically realizing) new options of flexible access.

The archive thus gets in motion; the storage of kinetic objects results in new types of retrieval which are based on differentiation along the temporal axis. The archivization of audiovisual arts results in a performative archive where the message of the medium is no longer the alphabet. Dynamic access replaces the static classification of the traditional catalogue, just like statistical probabilities have replaced particular knowledge in information theory, and pattern recognition replaces alphabetical identification towards open forms of adapting knowledge.

The presence of "historical" media *in implementation*

Electronic media place the concept of the past itself in a new temporal field. In the "replay" of a sound recording from the twentieth century, the clear perceptual distinction between the archivally organized traces of the past and the documents of the present is replaced by the immediate presence of the signal event. The experience of listening to this recording is no longer an experience of distance, as it appeals to the ears in the present at the level of the signal. When a magnetic charge is converted back into sound by the tape recorder, the signal actually takes place in the present—from the perspective of both human listeners as well as the machine itself. A gap that is hardly reflected in the philosophy of history thus opens up between the senses, which immediately perceive such signals, and cognition, which is constantly aware of their "history." In 2008-2009, the Institute for Media archaeology in the Austrian town of Hainburg organized a museum exhibition of "Magical Sound Machines."[227] This exhibition featured historical audio media that could be brought into operation for a short time, which enabled an entirely different experience of frequencies and dynamics at the level of acoustic archaeology

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227 Institut für Medienarchäologie (ed.), Zauberhafte Klangmaschinen. Von der Sprechmaschine bis zur Soundkarte, Mainz (Schot), 2008

than the supporting documentation was able to convey in writing. It is only through their sonic implementation that archaic sound generators prove to be actual media; the presentation thus focused on the temporary reactivation of the apparatus (particularly in the commissioned compositions of contemporary composers), which shifted the museum's emphasis from historicization to realization. For the purpose of conservation, such electrotechnical artifacts cannot be repeatedly reactivated, but once the sound event is reproduced it can be digitally sampled so that it remains available in the future. The sonic information thus becomes timeless information, which is free of the materiality of a specific storage medium. This makes previous media history subject to ahistorical contingency.

Anatomy of Kittler's modular sound synthesizer and Historical Performance Practice in Electronic Music

The past *is* present *in* its traces and is *made* present *through* reenacting its traces. For technological objects, the focus here is rather on operativity rather than shere matter. It is a trained archaeologist, Michael Shanks, at Stanford University who is co-editor of a volume on performantive arts called *Archaeology of Presence.*[228] Indeed, past media can be "re-presenced"[229] not by shere materiality; they reather require operative reenactment, operative presence. To what degree can textual and hermeneutic metaphors which have been familiar to humanities and performative arts be applied to electro-material culture? The circuitry design of an electronic media set is not a "text" but an *operative diagram* when set in function, in correspondence with the Peircean notion of "diagramatic reasoning" which is close to the archaeological method in its epistemological sense.[230]

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 explicit "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. This is hardware-oriented media hermeneutics in the tradition of what the archaeologist Eduard Gerhard once called *monumental philology* (Gerhard 1850).

But pure analysis does not suffice for media technologies; the operative testimony of an electro-acoustic synthesizer from the past is its actual re-

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228 Gabrielle Giannacci / Nick Kaye / Michael Shanks (eds.), Archaeologies of Presence. Art, Performance and the Persistence of Being, London / New York (Routledge) 2012

229 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

230 See M. I. Doran, Archaeological reasoning and machine reasoning, in: J.-C. Gardin (ed.), Archéologie et Calculateurs, Paris (Éditions du CNRS) 1970, 57–67

generation of sound. This links to Historical Performance Practice known from classic music rehearsals, and continues into the Electroacoustic Studio. The key word of operative media archaeology is not static reproduction, but rather dynamic reenactment. In contrast to sculptures and paintings, media art is operative and therefore a time event. Musicology employs the term "historically informed performance" in connection with the imperative to play instruments that are specific to particular historical periods. This aesthetic depends on the concept of early music, which for most musicologists refers to works composed before 1830. Ironically it thus ends at the time Michael Faraday just discovered electromagnetic induction, which was to become the condition of possibility for electroacoustic music in the future. The German Museum (*Deutsches Museum*) in Munich houses the legendary Siemens Studio for Electronic Music (1959-1969) which has been housing a couple of prominent composers. Does a faithful performance of early electronic compositions - analogous to the concept of "historical performance practice" - require them to be replayed in this museum studio? To what extent does electronic music depend on the original analogous instruments, and to what extent can these instruments be emulated as digital software? The historicity of early electronic music is not bound to an irretrievable original performance, like a piano piece from Mozart's era. Electronic music is not to be found in the studio production as progressive implementation, but rather in the final recording and composition on multi-track tape, as this is how it was first performed. If these tapes are available today, then a techno-historical equiprimordiality of re-performance can take place. One way of clearing a path to the past is the symbolic approach of writing-mediated historiography, but the other is the chronotechnical approach, which is grounded in material remains. The latter approach includes the media archaeology of the synthesizer. At the media art festival Ars Electronica in Linz in 2009, Elisabeth Schimana performed her composition "Hell Machine" (*Höllenmaschine*) on the same synthesizer that Robert Moog once constructed for composer Max Brand. This reactivation initially required hard work on the electrotechnical material, which is media archaeology in a manifest sense. While traditional historical instruments, like a grand piano from Beethoven's time, are mostly preserved in order to perform a corresponding historical composition, the message of an electro-acoustic artifact from the past lies in the primacy of the present. Schimana thus created her current composition specifically for the antique synthesizer: "What is in such a machine that has not yet been experienced?"[231] Electronic apparatuses of the past, conceived as media, are not in a historical condition, but rather in the mode of latent presence. Media archaeology seeks to unleash the potential sublated therein.

What remains: sonic "ghosts" from MP3 compression

In digital media culture nowadays, audiovisual "big data" need to be compressed for storage and transmission. This leads to a different kind of signal "discard" and "residual media"[232]. To focus attention of this digital sacrifice, research artist Ryan Maguirre applied a kind of acoustic "garbage

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231 Elisabeth Schimana posed this question during her presentation in the colloquium *Medien, die wir meinen* at Humboldt University, Berlin, February 10, 2010.

archaology" (Ratje) by re-collecting the sonic rubbish[233] left by the compression of "musical" data. The MP3 codec implements a lossy compression algorithm based on a perceptual model of human hearing which determined which sounds were perceptually non-important and could therefore be erased. What does such rejected data sound like? Patrick Maguirre has developed techniques to recover such lost sounds. The material left behind by MP3 data compression is worth listening for itself. "White, pink, and brown noise, when compressed to the lowest possible MP3 bit rate, sounds very different from the original random signal" (Patrick Maguirre).[234] Maguirre has produced an audio "[...] comprised of lost mp3 compression material from the song *Tom's Diner* which had been used as one of the controls in listening tests to develop the MP3 encoding algorithm: "Here we find the form of the song intact, but the details are just remnants of the original. The video is the MP4 ghost of a corresponding video [...]. Thus, both audio and video are the 'ghosts' of their respective compression codecs."[235]

While audio-visual attention to "the ghost" of MP3 files appears somewhat metaphysical, the laws of media applied here are rooted in techno-mathematical precision.[236] Probably the phantasm of "haunted media" (Geoffrey Sconce) better applies to analog, that is: signal-based media recordings only, not to digital data processing any more.[237]

True Computer-Archaeological Reenactment: Emulation

Reenactment is the reproduction of an event in a dramatic, that is: time-ordered form. The concept is also plausible for high-tech media theater, such as Heinrich Hertz's 19th century experiments with electromagnetic waves in the former lecture theatre of Technical University in Karlsruhe. In the era of digital media culture, the a-historical reproducibility of technical media yields entirely unique variants of reenactments. The Commodore 64 home computer from 1982, even if based on a low-clocked 8-bit processor with just 64 kilobytes of RAM, was graphics-capable and equipped with a sound chip. Its programs could be executed almost instantaneously, as the BASIC compiler made it possible to write byte values directly into storage cells and execute them with

232 See Charles Acland (ed.), Residual Media, Minneapolis (University of Minnesota Press) 2007. See further Caleb Kelly, Cracked Media: the sound of malfunction, Boston, Mass. (MIT Press) 2009

233 On the re-cycling of cultural value, see Michael Thompson, Rubbish Theory. The creation and destruction of value, Oxford UP 1979

234 See (or better: listen to) Ryan Patrick Maguirre's video *moDernisT*, created by salvaging the sounds and images lost to compression via the MP3 and MP4 codecs, from: http://theghostinthemp3.com; accessed January 4th, 2016

235 http://theghostinthemp3.com; accessed 4 Jan. 2016

236 See Jonathan Sterne (2012); MP3: The Meaning of A Format; Duke University Press

237 See John Durham Peters, Speaking into the Air. A History of the Idea of Communication, Chicago / London (Univ. of Chicago Pr.) 1999

the speed of a machine language. How can computer games originally written for the C64 be reproduced again decades later? The restoration of a C64 along with its peripheral equipment, including datasette, joystick, and television monitor, is actually marked by signs of decay, as both the hardware and the bit strings stored on the magnetic tape of the datasette have become prone to error. Despite such historicism, it is nevertheless astonishing that such a computer is still able to yield screen events and that it can still be used interactively after decades. The logic of hardware and software (microcodes in their fixed wiring and RAM and ROM data) proves surprisingly invariant with respect to techno-historical time and to the ageing of the electrophysical components. The medium is still able to position humans in the temporal relations that it operatively prescribes.

When antique computer hardware is simply exhibited on a museum shelve, its essential time- and *bit*-critical processes remains excluded. Its software belongs to the class of generic objects. "In archaeological terms the operational continuity of contemporary culture cannot be assured."[238] The solution lies in transforming the material aspects of computer culture itself into software - that is, digitally *emulating* the computer hardware of the past. This results in a media culture that practices its own *un*reification - "logical replication as distinct from physical replication."[239] Operational media are actually materially embodied, but they themselves no longer represent "things." It is the principle of the Universal Turing Machine that allows it to emulate all other machines with time-critical symbol operations. A new computer in the present *is* in the condition of a C64 when it emulates it, resulting in a new type of a-historicity. However, this only applies *per definitionem* to the logical, i. e. the symbolic level (the "archive" of statements); in order to become a real simulation, the current computer must take into account the earlier timing of the C64's electrical engineering as well, for the purpose of "high temporal fidelity." This requires consideration of the algorithmic sequence of changes in condition (logical, mathematical-dramatic time) as well as the concrete microtemporal intervals that add up to the overall behavior of the system. The result is the resurrection of a previous computer in the techno-mathematical world of its successors - a unique kind of temporalization. PegEm, the current emulation of the historic Pegasus computer once developed by the British Ferranti Ltd. in the late 1950s, admits that its simulation is limited: "Although no particular attempt was made to simulate correct timing, the similarity of the logic module to the actual hardware means that the various instruction times bear a reasonably correct ratio to each other."[240] The emulation models the logic of the Pegasus, but only the time behavior makes a replica exact: "The aim was to roughly model the gross timing behaviour of the original machine."[241] The computing cycles and time base of early computers must be handed down in order to be able to revive them in their temporal existence; current processors as "hosts" must take this into consideration in reverse engineering and media-

238 Doron Swade, Collecting Software: Preserving Information in an Object-Centred Culture, in: History and Computing 4.3 (1992), 209
239 Ibid.
240 Christopher P. Burton, Pegasus Personified: Simulation of an Historic Computer, in: Computer Conservation Society, http://ftp.cs.man.ac.uk/pub/CCS-Archive/Simulators
241 Ibid.

active archaeology.[242] Such technological anamneses are driven above all in the form of so-called retro computing, which practices anything but historical computer nostalgia.

The practical reproducibility of historical media technology represents an escalation of the question of the temporal modes of high-tech media. Emulation means functional equivalence in a time-invariant form. The Windows-compatible run-time environment for the WINE operating system says it already in its acronym (Wine Is Not an Emulator), since it does not emulate every processor instruction, but it is sufficient to allow the executed programs to run as fast as they did under the original operating system. This distinguishes symbolic machines from analog electronic media; the current reincarnation of a historic radio is only able to realize its model when the actual components are equivalently reused. Technological simulation is defined precisely by its temporal indexicality. Since the era of the analog computer, the time-scale modeling of a physical process is familiar through electronic elements (time compression and time expansion); worldly time behavior was thus modeled by worldly means. However, the term "simulator operation" was reserved for a specific temporal mode: the representation of dynamic and electromechanical processes in the time window known as "real time"[243]; flight simulators are a prominent example.

A final vote for algorithmic reenactment

If the theatrical drama is defined as formal procedure of processing time and space[244], then there is dramaturgy in machine agency as well. For computational media, this dramaturgy is truly algorithmic. Annie Dorsen has developed such a form of theatre co-created by algorithms, even envisioning a theatre without human actors. This is not post-dramatic theatre, but true media theatre: not beyond, but even from within the human body. The ultimate "de-personalization" by prosodic timing and rhythmic movement has already been Adolphe Appia's ideal for literally *automated* theatrial education.[245] Once theatrical space becomes mathematical, is challenges the traditional axioms of theatre like embodiment, presence, ephemerality, and human language in favor of formal languages.[246] Already in Samuel Beckett's one act play *Krapp's*

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

243 See Granino A. Korn and Theresa M. Korn, Electronic Analog Computers (D-C Analog Computers, New York (McGraw-Hill) 1952, 9.

244 As expressed in Adolphe Appia's *Die Musik und die Inscenierung* <sic!>, Munich (F. Bruckmann) 1899

245 "[...] wenn sein Körper den allerverwickelten Führungen des Rhythmus, sein Vortrag den seinem Seelenleben am fremdartigsten gegenüberstehenden Zeitmaßen wie von selbst gehorcht": Appia 1899: 41

246 Annie Dorsen's essay "On Algorithmic Theatre" (2012), originally published on the blog of Theater Magazine vol. 42, issue 2 ("Digital Dramaturgies" edition); accessed 24 May 2016: www.anniedorsen.com

Last Tape (1959), next to the human actor the real protagonist is the magnetic tape recorder which registers and replays the actor's autobiographical voice. While "peformance's only life is in the present"[247], operative acting is a multi-temporal fold. Traditional theatre counts a "time-based" art (as prominently argued in G. E. Lessing's 1766 essay *Laokoon*), but the "theatrical scene" of computation (true media theatre from within) dispenses with the familiar notions of the linear passage of time itself - even if in principle, the von-Neumann-architecture of digital computing still performs one step at a time. In times of Digital Humanities (which the term "algorithmicized Humanities" is more precise) code-driven media theatre becomes natural, rendering problematic the culturally familiar difference between performative *versus* operative media theatre. In an operative meaning, theatre is more machine related, in a performative meaning it is more body related; both converge in genuine Media Theatre which enacts retro-computing as present continuous past.

In Dorsen's media-theatrical piece, algorithms convert Shakespeare's *Hamlet* in real time into a computational co-presence that feels "out of joint" (to cite Shakespeare's piece itself), an almost *algorhythmic*[248] mixture: "That mix of rhythms turned into a jumble as language began to break down (in the last two parts of the show), giving the impression that the machine was breaking down" - algorithms going awry.[249] Such algorithmic re-production of dramatic speech is not as inhuman as it seems at first glance; it rather reminds of the mechanisms of oral poetry from within human performers itself, its specific mode of re-production. Oral epic poetry communicates knowledge of the past not in the mode of historical discourse, but as a memory, relegating past events to the present not by notational or signal recording (like written text, musical scores or presence-generating media such as the phonograph) but by variable iteration: invariance in dynamic transformation. In the age of algorithmic, that is: re-generative (instead of simply inherited) memory, a different kind *poiesis* of tradition emerges, known as the art of "live-coding" of computer music on stage these days.[250]

A rigorous theory of the media theatre does not stop with focusing attention to the new role of computational algorithms as cultural poetics; in a media-archaeological opening of its new techno-mathematical archive, it proceeds with a critical examination of the source codes themselves - not simply with the aim of philological re-reading, but re-executing. Before a human reader can make sense of such a text, it must first be logically be "understood" by a compiler or non-human literal "interpreter". The observer in this media theatre

/useruploads/files/on_algorithmic_theatre.pdf

247 Peggy Phelan, Unmarked. The Politics of Performance, 1993, 146 (as quoted in Dorsen 2012)

248 On that neo-graphism, see Shintaro Miyazaki, `Algorithmics. Understanding Micro-Temporality in Computational Cultures,` *online* `in: Computational Culture, Issue 2 / 2012, http://computationalculture.net`

249 Yucan 2015: 165

250 See W. E., `Sonic Time Machines. Explicit Sound, Sirenic Voices and Implicit Sonicity in Terms of Media Knowledge, Amsterdam University Press (series` *Recursions*`) 2016`

is not primarily the human spectator any more. Therefore the program code that is stored in a masked Read Only Memory (ROM) chip may become the target of media-archaeological or media-archival analysis. As long as the chip itself is embedded in a known computer architecture and assembly language, reverse engineering is able to recover the actual instructions stored in the ROM; "data" become clearly discernible. The microprocessor becomes the scene of media theatre where it actually happens. While human actors embody the textual script of a play for performance, integrated circuit chips implement a code which can be operated again even if obsolete or hidden. The Aperture Labs managed to read out the raw bits preserved in electro-magnetic remanence on Read Only Memory chips.[251] These were put through a disassembler and became re-readable as code.

Collections like the Computer Games Museum in Berlin and libraries are necessary to preserve past computer hardware architectures and software solutions. But in order not to reduce this to mere historical documents, the validity of mathematical algorithms have to be kept "alive" as tradition of past knowledge to the present.[252] It is possible indeed to identify Assembly code as charged elements in a Static Random Access Memory; a more evasive time-object is code stored in Dynamic RAMs. This has to be achieved as executable programs instead of passive reading - which makes all the difference to the Gutenberg Galaxy of printed typography, beyond the *stasis* of traditional textual archives, in favor of operative media theatre.

THE NON-NARRATIVE CHALLENGE. A TIME-CRITICAL REMARK

The anachronism of story-telling

Resulting from media materiality, media codes and media-based aesthetic form, in digital space, calculating replaces narrative, and temporal linearity is replaced by micro-temporal discontinuities; story-telling has become an anachronism itself in the time of time-based, time-critical electronic and digital media. The reality of signal-recording is time-axis manipulation; in digital space, emphatic notions of time turns into a function of arithmetical micro-timing, since digital media operate radically time-critical. Time here becomes the decisive factor - a non-narrative parameter, a kind of operativity which is rather ergodic (a term taken from statistical physics). Ergodic phenomena emerge in cybernetic systems (machinic or human) which operate as an information feedback loop, where a different semiotic sequence is generated each time it is engaged.[253] Virtual creatures may disguise in the form of

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251 See http://adamsblog.aperturelabs.com/2013/01/fun-with-masked-roms.html; accessed July 10, 2014

252See Friedrich Kittler, Museums on the Digital Frontier, in: Thomas Keenan (ed.), The End(s) of the Museum, Barcelona (Fondació Antoni Tápies) 1996, 67-80

253 Espen Aarseth, Aporia of Epiphany in *Doom* and *The Speaking Clock*. The Temporality of Ergodic Art, in: Marie-Laure Ryan (ed.), Cyberspace Textuality. Computer Technology and Literary Theory, Bloomington / Indianapolis 1999, 31-42 (33). This definition of ergodic processes somewhat differs from its definition in communication engineering (Norbert Wiener, Claude Shannon).

narrative, simulating stories - but in fact the apparent cinematisation of computer games practically reduces stories to *action*, and „the event space is not fixed before the time of play"[254].

Time processing has no exclusive narrative *a priori* any more, when its dominant medium is signal analysis of spatial movement, in video and computing. Telling itself becomes counting by numbers again.

"The sequence of operations required to perform a specific task is known as an *algorithm*"[255] - a digital aesthetics of writing a mere sequence of events in serial, sequential order.[256] Whereas narrative once has been the human art of organizing time symbolically (orally or in literature), time now is organized by technology itself. Codes provide for the structuring of its discrete elements - a media-dramatic concept unfolding in time.[257]

Algorithms displace the classical story-board, representing the aesthetics of CD-ROM: The script is not a screen-play any more, but code lines; the programmer is not interested in any narrative coherence, but rather writes discontinuous jump adresses to hot spots. Designing a Computer Game today means 95 % of digital administration (setting links), and just 5 % authorship are left. This programming practice is deconstructing narrative scenes into its most elementary morphological units. Linearity (which in the case of film is still based on the irreducable material linearity of celluloid) has articifially to be introduced on CD-ROMs if one wants guide-lines.

Digital story-telling in the moving image[258]

By sampling, all sensual dimensions become quantifiable - even the temporal resolution. A century ago the invention of the moving image has not been targetted to story-telling, but as a means for measuring movement - a non-discursive practice.

While making the previous cultural technique theatre the content of the new medium, the moving image technology started to develop its own aesthetics: cutting (technical), editing (conceptual), "selection, timing and arrangement of given shots into a film continuity", under-cutting the superficial story on the level of discrete perception. Wsewolod I. Pudowkin's idea of discontinuous film cutting and editing led to a culture liberated from the primacy of coherent

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254 Aarseth ibd., 35

255 J. D. Richards / N. S. Ryan (eds.), Data Processing in Archaeology, Cambridge U. P. 1985, 1f

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

257 Monika Halkort, Datenbankbasiertes Broadcasting - Neue Erzählgenres im Netz, in: do it yourself! Kunst und digitale Medien: Software - Partizipaton - Distribution, hg. v. Andreas Broeckmann / Susanne Jaschko, Berlin (transmediale.01) 2001, 155-159 (155)

258See the essay by Charles B. Slocum "The History of the Future: We Have Seen It, and It Was Digital" <= www???>

narrative, literally counting with cuts and gaps.[259]

The effectiveness of computer-enhanced animation suspends the physiscal limits of real life, just like Heinrich von Kleist in 1800 already preferred the mechanic puppet to human dancers for their better anti-gravity movements (*Das Marionettentheater*), and some of his dramas seem to perform the logic of binary electric impulses.[260] Grace in movement can artificially be achieved better than by training of human bodies. In Samuel Butler´s novel *Erewhon* (an acronym for "nowhere") from 1872, machines perform what Deleuze and Guattari once called "an-organic bodies".

The impact of digital effects on live-action storytelling is not just extended exponentially, but films like *The Matrix* with a kind of data rain visually represent the complete take-over of the digital. Humans thereby are no longer the masters of the universe, but merely one of the many neatly aligned fragments in the digital "matrix". Pythagoras declared: The world consists of numbers; like a Moebius-loop, this trope of media culture now returns to us.

According to Marshall McLuhan, the media form of communication inherently affects its content. Digital storytelling is not so much about the viewer choosing from alternate endings but rather a function of automated algorithms which combine key-words in a voice-over story with a data bank of video files, such as realized in Lev Manovich's *Soft Cinema*. The system randomly (by the LINGO program) selects from a video data bank short movies which superficially fit to the textual stories displayed: "While the voice over which narrates the stories was edited before hand, everything else in constructed by the software in real time, including what appears on the screen, where, and in which sequence. The decisions are based partly on a system of rules, and are partly random. <...> Soft Cinema can be though of as a semi-automatic Vj."[261] The split screen layout is taken from well-known financial TV, combining narrative with loops; its form leads to data-based cinema.

The cybernetics of feed-back

Digital aesthetics, with its *Windows* perspective, its archival desktop-metaphors on interfaces and with its hypertextual logic privileges the topological - mapping rather than telling. This aesthetics is already re-invading classical media like film, f. e. Mike Figgis´ *Time code*, and the "dreamlike quality" in David Lynch´s film *Lost Highway* delinearizes cinematographic story-time itself.

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259 Wsewolod I. Pudowkin, Über die Montage, in: Texte zur Theorie des Films, ed. Franz-Josef Albersmeier, Stuttgart 1979, 77f

260 See Gerhard Pickerodt, Heinricht von Kleist. Der Widerstreit zwischen Mechanik und Organik in Kunsttheorie und Werkstruktur, in: Hanno Möbius / Jörg Jochen Berns (eds.), Die Mechanik in den Künsten, Marburg (Jonas) 1990, 157-168

261 Handout DEAF03 festival

Cyberspace is not primarily about space but about cybernetics - the transformation of linear narratives into nodes and nets. No longer bound to physical places, the virtual adresses exist in mathematical topologies only.[262]

According to Heinz von Foerster, cognitive processes in humans are comparable to computable cybernetic algorithms.[263] Jacques Lacan´s essay on "Cybernetics and the Language of the Unconscious" discovers algorithmic procedures as a target for psychoanalysis, with the so-called human subject being itself an automaton in the sense of "cybernetic doors" (how he calls it), on/off operations, switching.

Telling by numbers

The earliest (media-)archaeological traces of writing (symbolic inscriptions) from the Iraque area is numbers rather than pictograms, counting rather than narrative language.

The digital did not start with the computer (which, more precisely, means the binary code), but from the moment when an unknown adaptor of the Phenician alphabet in ancient Greece added singular letters for vowels to the known consonant writing system, in order to be able to record mechanically, even phono-graphically what could have been so far only orally performed: the Homeric epics (the *Iliad* and the *Odyssee*). The "hot" (McLuhan) alphabet, not being dependend on the reader´s vocal interpolation of vowels in reading aloud, implicitly deconstructed the idea of the uninterrupted flow of story-telling of poetic bards by deconstructing speech into single meaningless units (the letters of the alphabet) from which all kind of linguistic meaning could be re-composed. This technological operation philosophically implied that the world as such (physis) might be composed from single atomic units: the idea of the "elements" (denominating both the letters of the alphabet and the smallest physical units) was born by this media technology.

The ancient Greek term *techné* encompasses both the artistic / aesthetic and the machinic. Deconstructing the world into smallest elements (*stoicheia*) such as letters of the alphabet, elements in physics, musical tones has become an arithmetic operation since. The computational age re-enacts this procedure on a even more fundamental level, since not only speech, but any kind of signals is being decomposed when given to the computer in A/D conversion. Bits are indifferent to cultural meaning.

"To tell" as a *transitive verb* means to „to count things".Media artist David Gordon, in his gallery cinema installation *24 hours Psycho*, media-archaeologically undermines the thrilling story by slowing it down ultimately to the single frame. Time-based media lead to the re-entry of narrative as calculation, as can be demonstrated in media art installations such as Angela

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262 See Albert Lichtblau, Cyberspatial Monuments of Memory, in: Gerfried Stocker / Christine Schöpf (eds.), Memesis. The Future of Evolution, Wien / New York (Springer) 1996, 234ff

263 See Heinz von Foerster, Kybernetik und Erkenntnistheorie, in: same author, Kybernetik und Bionik, Oldenburg 1974

Bulloch´s *pixel boxes* which slow down and enlarge digitized film frames to an almost abstract extreme. Counting movies by pixels (and be it the most Hollywood-like) is an indexical procedure, no story any more.

In his essay on "Data banks as symbolic form", Lev Manovich points out that in a media culture where the data model becomes primary, narrative becomes subject to data logistics (programming); thus the aesthetics of database inverts the traditional supremacy of story-telling (the syntagmatic) in favour of the paradigmatic (thus non-narrative). "Drowning by numbers" (Peter Greenaway) is the reality behind what appears like story-telling on the computer screen. So info-aesthetics, skilled data navigation and coding creates a more transient relation between interface and the machine - the media-archaeological mode.

Turing tests

What does a "digital human" look like? A digital *persona* (mask) of Marshall McLuhan himself might be endowed with a voice generator which converts his *Understandind Media* (1964) into audible speech. The medium becomes the essential message itself: the digital in its algorithmic operativity, never really addressed by McLuhan himself. Software animates McLuhan's face with his own textual quotes, undeadly. "Will the hypermedia make us all superhuman? <...> How is the human identity changing in the digital-media environment? asks our conference draft. But maybe any expression like the "digital human" is already a *contradictio in adiecto*. We all know the motiv of the deadly Siren songs which are meant to seduce all listeners in Homer´s epic *Odyssee*. What sounds like the sweetest human voices is not human at all. Recording technologies of real voices since undermine the humanist certainties.

When the ethnologist M. Selenka went to the tribe of the Wedda in India in 1907, she made the natives speak or sing into a phonograph which have been preserved and digitally converted in the Berlin Ethnographical Museum.[264] Is this still the human voice which we hear, or its digital re-birth? Is all that noise the recording machine (phonograph) which speaks, like the android lady Hadaly in Villiers de l´Isle-Adam´s novel *L`Eve future*, created by Thomas Alva Edison, the inventor of the phonograph, himself? The digital human starts with Edison naming his son and daughter "dash" and "dot".[265] As well in E. T. A. Hoffmann´s novel *The Sandman* the lovers of the android Olimpia have to be pleased with her monotone linguistic repertoire; Olimpia, "froide a toucher", though is able to express herself on the piano - a discrete automaton. Furthermore, she manages to sing admirably (from record?), "mais ne sait, hélas, dire que `Ha! ha!´ et `Bonne nuit, mon cher". This leads us to the machinic inside of the human, like the one answer repeated endlessly in Herman Melville´s short story *Bartleby* by the protagonist against his office orders: "I´d prefer not to." The iterative is the machinic, just as in computer games the option of "repeat" is symbolically undoing the ontological condition for narrative, death-in-time.

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264 Quoted after: Max Wertheimer, Musik der Wedda, in: Sammelbände der Internationalen Musikgesellschaft Jg. XI, Heft 2 = Januar-März 1910, 300-309 (300)
265 See Dieter Daniels, Kunst als Sendung, Munich 2002, 71

In his essay "Intelligent Machinery. A Heretical Theory" (1959) Alan Turing once declared that a disciplined human being, provided with paper, pencil and erasor is already a universal machine; he calls such a combination of a human with written instructions a "paper machine". And indeed, when we calculate in our mind, we become a function of a formalistic prodecure, in fact: a symbolical machine ourselves, non-narrative, non-narratable.

Non-historical media temporalities

There are symptomps of an uneasiness with the dominant historiographical model of organizing knowledge about past media times, in favour of reckognizing nonlinear 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 theorizing about the minimal energy loss in machine work. In the information age, Shannon's mathematical definition of entropy for digital information engineering has since replaced its thermodynamic meaning.

History of science still subjects technical media to an overall human discourse. Media archaeology takes the other point of view, emphacizing the "non-human agencies" as Bruno Latour calls it: the proper time (Eigenzeit in physics) of technical media. In an up-dated version of Platon's conceptual *anamnesis*, there is a co-emergence of technical logics and subjective human knowledge. Technology needs humans to become explicit, although (like in psychoanalytic practice) being there already in latency.

Re-entry of the alphabet: media archivology

Archives and other such storage agencies are not in the past but radically present. A theory of storage does not confuse it with "cultural memory" or even human "remembrance". Archives, libraries and museums are symbolical machines, while at the same time, they differ in their function between respositories of material objects (museums), places of unique records (archives) and collections of public reproductive knowledge (libraries).

There is a difference between the book as material storage medium for symbol transmission and as a (data) format (like the ancient codex with single pages different from the papyrus scroll). It will be dis-continuously "migrated" to new carriers and interfaces - each time a "catastrophe" (data loss). On a more fundamental media-archaeological level, there is a return of the printed alphabet - which seemed to be out-dated by signal recording and transmission in audio-visual media like the phonograph and electronic radio and television broadcasting - within computing as alpha-numeric source code and strings in computer programing; a unit of bits is even called "word" (even if this new alphabet disguised under the appearance of digital sound and images). As a kind of retro-effect of ephemeral *online*-access to knowledge ("open access") the material book gains strengh as enduring object.

MEDIA ARCHAEOLOGY: A CRITIQUE OF NARRATIVE MEMORY

Media materialism: Cultural technologies and Nietzsche´s typewriter

In media archaeology, the notion of communication rather relates to Claude Shannon´s *Mathematical Theory of Communication* (1948) which does not mistake communication for mutual human understanding. Conceptual media archaeology is neither about re-discovering the loosers 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" reminds of the archaeological meaning of computing, its hardware relays, signal processing by electric fluidity and swichting boards.

"[T]o exaggerate slightly, the screen divides new media studies into these two fields. Visual culture studies stem from the Anglo-speaking academy and generally treats the interface, or representations of the interface, as the medium. The second approach, media archaeology, although inspired by Marshall McLuhan and Foucault, is mainly Germanic [...]. Taking as its ground zero McLuhan's mantras of 'the medium is the message' and 'the content of a medium is always another medium,' media archaeology concentrates on the machine and often ignores the screen's content. Archaeological studies critique visual culture studies' conflation of interface with medium and representation with actuality; visual culture studies critique the archaeologists' technological determinism and blindness to content and the media industry."[266]

Inbetween stands Lev Manovich´s notion of "cultural software". Manovich separates between the cultural and the technical level in the computer; the term "cultural engineering" (German *Kulturtechniken*) links both.[267]

Media archaeology focuses 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 repetivitive temporeality in contemporary media culture.[268] 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

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266 Wendy Hui Kyong Chun, Control and Freedom. Power and Paranoia in the Age of Fiber Optics, Cambridge, Mass. / London (M.I.T. Press) 2006, 17

267 See Theory, Culture & Society, vol. 30, no 6 (November 2013), special issue *Cultural Techniques*

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

complex event in digital space for what the human perception still conceives as "present".

Media archaeology takes as its actual model and point of departure the digital condition of contemporary culture, by opening the horizon ranging from the elementary ancient Greek vocal alphabet across Raimundus Lullus´ combinatorial "memoria artificialis" which operates with the idea of the discrete, stochastic "alphabet" of terms[269], 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 (*elementa*, or even *stoicheia*, the Greek expression for both single alphabetic letters and atomic units in nature). It has been a crucial moment - rather archaeological than historical, since not immediately reflected in cultural terms - when the invention(s) of the discrete alphabet (as opposed to ideographic writing systems like the Egyptian hieroglyphs) cut down the human language into smallest elements which are meaningless in themselves, from house (*beth*) to "B", so to say. At this moment the machines take over, since only machines can perform symbolic operations without any semantic referentiality (which hinders effective data processing) at all, purely syntactically.

The discrete alphabet materially refers to a prominent media-archaeological artefact. A small exhibition at Weimar 2002 grounded so-called Weimar culture as rupture between classicism (Goethe) and modernism (Nietzsche) in two media-archaeological artefacts: Goethes mechanical pencil and Nietzsche´s typewriter. Different kind of content has been produced by such different devices, as explicitely expressed by Nietzsche: "The writing instrument co-produces our thoughts." Media technologies are not simply functions of historical and cultural discourses. On the contrary, the French *Apparatus* theory, notably Marcelin Pleynet, took account of the ideological *a priori* (in the Kantean sense) of the technical apparatus: "[...] l'existence non significante d'un appareil producteur d'images, qu'on peut indifférement utiliser à ceci ou à cela, à droite ou à gauche. [...] les cinéastes auraient intérêt à s'interroger sur l'idéologie que produit l´appareil (la caméra) qui détermine le cinéma"[270], for instance "une caméra productrice d´un code perspectif directement hérité, construit sur le modèle de la perspective scientifique du quattrocento" (ibid.).

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

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269 See Sybille Krämer, Symbolische Maschinen: die Idee der Formalisierung in geschichtlichem Abriß. Darmstadt 1988, 88
270 "Éconimique, idéologie, formel ...", in: Cinéthique no. 3 (1969), 10

Vocal machines

In occidental logocentric epistemology, there is a vibrational event which looks most human: the voice. Machines for artificially synthesizing vowells like "a-e-i-o-u" have been construced. Once sound waves and frequencies of the human voice were mathematically (that is: "really", not simply symbolically by the vocal alphabet / *stoeicheia*) analyzed, they became computable, starting with a Leonard Euler in St. Petersburg, a contemporary of Immanuel Kant, when in 1739 he developed his music theory and chose the analytical way to approach human articulation (the Euler equations).

Truly *media*-archaeological analysis of cultural articulations (be it artefacts of voices) takes place when media themselves become the technical tools of analysis, just like in early chrono-photography which was meant to analyze the movement of horses unpercetable by human eyes since too fast. The interest is not in representation but in techno-operative measuring, as opposed to the performative use of cinematography for narrative film projection.

Beyond media-anthropomorphism, the technical functionen can be performed much better by not imitating living beings, but adopting to the genuine physical signal event. Such media are not McLuhan's extensions of man any more, but rather they subject man to the apparatus. In 1878, Edison describes in a patent one of the possible uses of the phonograph as speech generator, "to teach the relationship between each letter of the alphabet and its sound: a set of typewriter keys, each labelled with a single letter, activated the playback of individual sections of a long cylinder that contained the spoken forms of those particular letters".[271]

Siren songs and *Musurgia*

Media archaeology has a different reading of the Siren songs in Homer's *Odyssey*. The epic explicitely (by using the grammatical archaic form of the dual at song 12 line 52 and 167) names t w o Sirens which can only be explained by an archaeology of early Greek music (enharmonics, the double-flute *auloi*). A literal reading of such "ambiguity"[272] surrounding the Sirens' song comes close to Maurice Blanchot´s interpretation of the "superhuman"[273], not even anthropomophic Siren motive. Thus the Sirens do not simply "present the most serious female challenge to the authority of the *Odyssey* narrator"[274], but rather a challenge to the idea of the human voice as such, just like in the so-called Turing Test the gender question and uncertainty is extended to the human-machine communication at all.

Already Descartes deciphered animals as automata. Media archaeology refers to the uncanny in the human itself (like von Kempelen's artificial chess-player

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271 Hugh Davies, A History of Sampling, in: Feedback Papers 40, Cologne (July 1994), 2-15 (4)
272 Lillian Eileen Doherty, Siren Songs. Gender, Audiences, and Narrators in the Odyssey, Ann Arbor (University of Michigan Press) 1995, 61
273 Doherty 1995: 136
274 Doherty 1995: 139

referred to in Benjamin´s *Theses on the notion of history*). Siren voices - what did they sound like? Operative media archaeology actually explored the acoustic uniqueness of the Li Galli isands in the Gulf of Positano at the Italian Amalfi coast in early April 2004: a range of experimental sounding and measuring, from two opera singers performing the Siren song lines which are in Homers´ *Odyssey*, up to an electronic sampling of the kind of noise which is produced on these islands by bees, by the wind, by the waves.[275] Thereby the sono-sphere has been given the chance to express itself by help of most advanced sonic technologies, assuming that (like Schliemann excavating ancient Troy) the Sirens were not just poetic fiction but there is implicit local knowledge which has been preserved in cultural aocustic memory. Sound frequencies belong to the regime of the real, not the symbolical, and (according to Jacques Lacan) the real always returns to its place. Media archaeology is as close to natural or technical sciences as it is to academic humanities.

A recurrence of bodiless or technological (thus: monstruous) voices is the phonograph which for the first time made the voice not only symbolically (alphabet) but physically signal-recordable. Reverse phonography is acoustic media-archaeology. In Gregory Benford's novel *Time Shards*[276], workers at the Smithsonian Institution prepare a time capsule to be buried in 2000 AD, while a scientist tries to resurrect voices from 1000 AD. As suggested in Paul DeMarinis' media-artistic installation *The Edion effect* we can listen to the voices of people from a thousand years ago by rading grooves on pottery.

Different from such wave forms is discrete acoustic signal processing, known from an instrument appropriately called "Siren" for war attack or fire warning. The technical Siren was developed by Charles Cargniard La Tour in 1819 and improved by Hermann v. Helmholtz, linking discrete sound production (the siren / the alphabet) to the mathematics of Fourier series: auditory perception as a machinic process. The composer Edgard Varèse, in his piece *Ionisation*, performed this "corporification de l´intelligence qui est dans le sons". With the introduction of the optical film soundtrack in the end 1920s, sound could be photoelectrically recorded on a narrow track beside the visual images and therefore even be monitored and visually analysed itself. Most of the early electro-acoustic instruments like photoelectric organs from the late 1920s and the 1930s were based on a rotating disc that interrupted the passage of a beam of light between its source and a photocell to avoiding mechanically direct contact with the surface of the recording. "Many of these sytems used a principle derived from that of the siren, interrupting the light-beam by a rotating opaque disc in which holes or slits had been cut."[277] Synthesizers take over - between the analog and the digital. Athanasius Kircher once designed a machine to compose music with stardardized set pieces, the *Arca musarithmica* from his study on Baroque music in 2 volumes *Musurgia universalis* (Rome 1650). Music automata, as the precursors of computer-

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275 See W. E., Towards a Media-Archaeology of Sirenic Articulation. Listening with media-archaeological ears, in: The Nordic Journal of Aesthetics, No. 48 (2014), 7-17
276 Orig. 1979; electronically *online* 2000: FictionWise eBooks
277 Davies 1994: 6

programmable music, allowed for music to unfold without a human musician being present.[278]

The Sirens in Homer´s *Odyssey* uncannily remind humans that their own voice may not be that individual but be reproducible by a technical vocoder. Such automata are by no means imaginary or allegoric but rather, with Descartes, they reveal the automativity within the animal itselt, just like Norbert Wiener's *Cybernetics* (1948) explictely correlates communication and control in the animal and the machine. The sublime epistemological challenge of technical media addresses the notion of humanness itself. In fact, the media archaeological impulse and method - as apposed to media anthropology or media sociology - is to take the perspective of the machines in order to get liberated for moments from the subjective human view.

Voice signal recording

The nature of memory agencies like the archive or the library has changed since signal recording (like phonography, or video) started to rival the traditional textual record. While archival document criticism and the historical method of organizing past data is necessary and plausible in remembering cultural pasts, it is not the only way to model past times. There is a shift of emphasis; to take an example from sonic archaeology: the phonographic collection of early voice recordings (Lautarchiv) based at Humboldt University, Berlin. The phonological target was inscribed into the Lautarchiv by its promotor Wilhelm Doegen from the beginning. The Lautarchiv encompasses a) voice samples by famous characters, b) truly archival recordings of local speech dialects, and c) recordings for musical ethnology, mostly Africans and Indians from the French and British Army prisoners in the World War One "Halbmond" camp at Wünsdorf south of Berlin. While cultural analysis concentrates on this ethically ambivalent historical and discursive context, with a different epistemological vantage point media archaeology lends its ears to knowledge which can be derived from the actual media articulation contained in the technical archive itself.

Even the most rigid media archaeological argumentation as academic method is still verbal or textual. But it allows for non-discursive matters to be recognized. Technical media have become time objects in themselves, they enact the drama of signalling past to present, such like Enrico Caruso's voice from an ancient gramophone recording all of the sudden is being experienced as radically present voice in the human listening perception. The media-induced affect is radical presence, or "re-presencing" (Vivian Sobchack).

Sound archaeology

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278 See Sebastian Klotz, *Ars combinatoria* oder "Musik ohne Kopfzerbrechen". Kalküle des Musikalischen von Kircher bis Kirnberger, in: Musiktheorie Bd. 14 (1999), Heft 3, 231- 245; for the link between music automata in Arabic medieval culture and current computing, see Shintaro Miyazaki, Algorhythmisiert. Eine Medienarchäologie digitaler Signale und (un)erhörter Zeiteffekte, Berlin (Kulturverlag Kadmos) 2013

If sound is evasive, liquid, in itself unrecordable and transferable beyond the bodily range, then technical media (different from alphabetic phonetic writing which "freezes" the human voice by reducing it to a range of a very limited symbolic code) are able to de-freeze recorded voices in all its frequencies in re-play as heritage of the Edison wax cylinder. The author Arthur Schnitzler knew it, when speaking into the phonograph on 19th March 1907, thus admitting that confronted with the phonograph literature had lost its unique privilege to transmit the memory of human language.[279] But any replay of such a recording will result as well in the scratching, the noise of the recording apparatus itself. True media archaeology starts here. The auditive equivalent to the media-archaeological cold gaze is cold listening.[280]

It is still an undigested shock in the cultural unconscious that we are able, today, to listen to bodyless human voices which exterminated hundred years ago, by applying laser reading of the wax cylinders which do not destroy its source in the act of re-play. But what do we hear: Message (the vocal articulation) or noise (the scratch)? The micro-physical *close listening* to sound, where the materiality of the recording medium itself becomes poetical, dissolves any semantically meaningful archival unit into discrete blocks of signals. Instead of musicological hermeneutics, media-archaeological understanding is required here. The media archaeologist, without passion, does not hallucinate life when he listens to recorded voices; his exercise is to be aware at each given moment that we are dealing with media, not humans, that we are not speaking with the dead but dead media operate.

Media archaeology - against media anthropology? Karsakov 1832

Does human performativity differ essentially from technical or algorithmical operativity? Semen Karsakov´s text *Aperçu d'un procédé nouveau d'investigation au moyen de machines à comparer les idées*, St. Petersburg 1832, was at first unretrievable, because of the wrong spelling "Korsakov". Every letter changes the address in storage techniques like libraries or computer memories. Here, media archaeological research literally requires media archivology.

Karskakov once worked in the statistical department of the Russian Police Ministery in St. Petersburg. In his machines, data was recorded (and stored) on punched cards. Punched cards were, at the time, introduced in France in 1805 by Jacquard for controlling his textile machines. Korsakov implement them for informatics, in anticipation of Hermann Hollerith. He defined in his own terms and presented the conception of artificial intelligence as an "auxiliary amplifier

279 Phonograph record signature Ph 536 in the Vienna *Phonogrammarchiv* (Austrian Mediathek)

280 "`Der Phonograph hört eben nicht wie Ohren, die darauf dressiert sind, aus Geräuschen immer gleich Stimmen, Wörter, Töne herauszufoltern; er verzeichnet akustische Ereignisse als solche.`" Friedrich Kittler, Grammophon - Film - Typewriter, Berlin (Brinkmann & Bose) 1986, 39 f.

for natural intelligence".[281] Emphasizing the decisive meaning of the alphabet which enabled humankind to "impress ideas onto (physical) matter" up to appearance of the synoptic tables in the Modern Age, Korsakov developed his idea further on to suggest the combination of these tables with a mechanical processing device so as to facilitate (automate) the "comparison of ideas". He called such devices "machines intellectuelles", and predicted their intensive future development. "Just as the telescope and the microscope provided the additional power to our eyes, the intellectual machines would limitlessly strengthen the power of our thought (mind), as soon as distinguished scientists apply their knowledge to studying the principles of this process and compose the tables necessary for its application in various fields of the human knowledge."[282]

Thus Karsakov took seriously into account what the novellist Giacomo Leopardi in his *Proposta die preme fatta dall´Accademia dei Sillografi* in 1824 where he described his age as "l´età delle macchine", where "non gli uomini, ma le macchine, si può dire, trattano le cose umane e fanno le opere della vita"[283].

Data anthropometrics

The reason for the existence of archives has for centuries been the legal memory of the state, not the imperative for cultural memory. Media memory is not primarily for cultural use; images from (surveillance) data are nothing but iconic abbreviations of a statistical data avalanche which would otherwise be unperceivable, unmasterable by human senses. What the constant data stream of pictures from surveillance cameras acutally performs is a film-making of a different kind, a kind of aesthetics which was re-translated into film by Mike Figgis' *Time Code* (USA 2000) which advertised that "for the first time, a film shot in real time"[284]. Heiner Mühlenbrock´s video assemblage of footage from material of surveillance cameras in the Berlin International Congress Center (ICC) is appropriately named *The ice-cold eye* (1989/90). In such a truly media-archaeologal perspective, the traditional story board is replaced by the non-narrative logic of the camera itself; its electronic indifference opposes the culturally coded (rather than anthropologically natural) longing for story-lines in life and in movies: no cameraman, no director, no script, no actors, and no story[285], rather *imaging*.

The punched card

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281 See Wladimir Velminski / W. E., Semën Karsakov: Ideenmaschine. Von der Homöopathie zum Computer, Berlin (Kulturverlag Kadmos) 2007

282 Karsakov 1832: 8

283 In: Le Operette morali, Florenz (Sansoni) 1931, 30 ff.; quoted here after: Hilda L. Norman, Leopardi and the Machine Age, in: Otto Mayr (ed.), Philosophers and Machines, New York (Science History Publications) 1976, 147-157 (148)

284 www.sony.com/timecode

285 Heiner Mühlenbrock, The ice-cold eye, in: Levin / Frohne / Weibel (Hg.) 2002: 614

With the numerically punched card, images from data gernerate a trans-visual memory in Descartes' sense, no more visual *artes memoriae*.[286] Textile imagery in the subsequent Jaquard loom were derived from punched cards which literally in-formed the weaving of textile images.[287] Charles Babbage contained a punched-card based woven portrait of Jaquard in his office. In reverse, Ada Lovelace's notes on the Analytical Engine pointed to the option of computationally weaving "algebraic patterns". The analytical engine is itself a media archaeologist, performing data processing which humans can never do in that speed. In textile processing, the fabrication of the tissue - just like with electronic pixel images - follows a pre-structuring by lines, columns and puntual elements; such image weaving operations results from the logic within the machines itself which is ultimately a mathematical logic. Whereas Babbage, for his Analytical Engine, was inspired the image-producing Jacquard loom which is a programmmable medium to calculate numbers, later the number crunching machine called computer produces images from numbers. This kind of Moebius loop is the figure of media archaeology, a figure which is alternative to historiography and terms like evolution, development, progress. There is rather a mechanism of strange attractors at work which can be media-epistemologically specified down to its techno-logical components.

Images from data

Media archaeology looks at images not iconologically, but with the "cold archaeological gaze": as lots of data (once scanned into digital space), thus calculable, rather than narratable. The electronic tunnel microscope does not actually transfer images of the atomic surface of matter, but analyses its object by matching data statistically and representing these calculations as images - just like bats do not perceive space iconically, but by echo orientation in space.

Media archaeology is akin to the gaze of the optical scanner other than the "ethnographical" gaze. An image, for media archaeologists, is different from what an image is to art historians or Visual Studies. The media archaeological gaze is close to radar which is rather a "system of measurement rather than communication"[288]. Radar is an analogue technique rendering a physical image (rather map) of the surrounding area of an antenna, while on the level of signal transfer it operates with discrete impulse- and duplextechnology. Thus the radar image is rather analytical (a measuring device) than a medium of representation, of projection (like mass media). Both though, TV and radar, are based on the same cathode ray tube; actually the German TV set which was ready to go into mass production in 1939 was immediately converted to military uses after the outbreak of WWII.

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286 This epistemic rupture has been described by Frances Yates in *The Art of Memory*

287 See Birgit Schneider, Textiles Prozessieren. Eine Mediengeschichte der Lochkartenweberei, Berlin / Zürich (Diaphanes) 2007

288 Woodward 1950, as quoted in: Friedrich Wilhelm Hagemeyer, Die Entstehung von Informationskonzepten in der Nachrichtentechnik. Eine Fallstudie zur Theoriebildung in der Technik in industrie- und Kriegsforschung, PhD thesis Berlin (Freie Universität) 1979, 341

Media archaeology is not only a form of research, but as well an aesthetic of observation - the passion for distancing, corresponding with the gaze of the camera (proclaimed by Dziga Vertov as "Kinoglaz") or the digital monitoring system which has long replaced the tele*visual* panoptical regime of video cameras by data patterns and clustering. The radar image is a form of signal intelligence, in a very precise technical translation of the Greek term *theoría*. Radar in fact embodies something like "the inverse principle of broadcasting ("das inverse Prinzip zum Rundfunk"[289]).

That is why media archaeology is the other side of the coin of mass media studies in that it does not focus on one-way signal transmission of intelligence; unlike broadcasting, rather like radar, it gathers intelligence from technological surroundings and from within the "black box".

The cold (media-)archaeological gaze versus warm historical imagination? Farocki *versus* Cameron

The cold camera-eye gaze of *tele*visonary media relates to media-archaeological aesthetics; Nietzsche´s "pathetic distance" corresponds with Michel Foucault´s insistence on the exteriority of analysis, as opposed to hermeneutric empathy. The media-archaeological gaze is *cold* in McLuhan´s sense of differentiating between "hot" and "cold" media - with the later ones inviting the human receiver zu participate actively in putting data streams into relation(s). When media themselves become active archaeologists of data, the cold gaze of the machinic eye is no eye any more but an element in cybernetic feedback systems, as expressed in Harun Farocki's video film series *Auge / Maschine*. Does it make sense for media theory to metonymically apply the catgory of the human gaze to machine vision? Dziga Vertov, in his film *The man with the camera*, makes the camera-eye (the KinoGlaz) the agency of vision.

In Alfred Hitchcock's film *The Birds*, at one point, the camera switches to the birds-eye perspektive from above, where the whole scene looks completely different, more like a configuration. In fact, the overall perspective in this film is, technically, the camera eye. In technical systems, the notion of "seeing" itself becomes metaphorical; while communicating, signals are being compared - no more camera "eye". In C3I technologies, Command, Control, Communications and Intelligence converge. Cruise Missiles are guided by matching pre-recorded with actually perceived visual maps (operative images), like in GPS not images but topological data are being communicated.

The past search for the wrack of the ocean liner *Titanic* has been a true act of submarine archaeology. While the gaze of the camera is able to look at this archaeologically (that is, purely evidentially in the sense of remotely sensing data), the human eye immediately confounds evidence with magic when it comes to "re-presencing"[290] of such relics. "Out of the darkness, like a ghostly

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289 Hagemeyer 1979: 341
290 See Vivian Sobchack, Afterword. Media Archaeology and Re-presencing the Past, in: Erkki Huhtamo / Jussi Parikka (eds), Media Archaeology. Approaches,

apparition, the bow of a ship appears [...] just as it landed eighty-four years ago", expresses the screenplay of James Cameron´s *Titanic*, and film director James Cameron recollects his search: "Initially <...> I was like the astronauts who experienced the moon as a series of checklists and mission protocols" - the true archaeological gaze. But "at a certain point I abondoned 'the plan' and allowed the emotional part of my mind to engage with the ship. It made all the difference in the world."[291]

Hermeneutic empathy (instead of navigating data) is a rhetorical figure; the gap between an *archaeology of knowledge* and historical imagination opens which seeks to replace positive evidence by reanimation. What is sonar echoing in submarine archaeology becomes *resonance*. But let us not confuse data with life. Sometimes the iconological impulse as cultural knowledge of contextual image-reading even hinders operative insight. The image search machine of the company Cobion at Kassel, Germany, f. e. once crawled the Web for pornographic child abuse images - a task which, for humans, is painsome.[292]

The Greek notion of "(h)istor" (for witness) derives from the linguistic root *w(e)id* (to see, to know) just like in "video".[293] The visual metaphor of ancient Greek *theorein* is linked to theatre and to "evidence" in law. Media "theory" itself recognizes that the occidental links between the optical regime and epistemological insight is being replaced by the numerical sublime, that is: mathematical calculation.

The US minister of foreign affairs, Colin Powell, once presented "undeniable evidence" of Saddam Hussein's mass killing weapons in the Iraque to the UN Security Council on February 5th, 2003; but these satellite images were fuzzy. And during the Bosnian War, when in July 1995 Serbian soldiers systematically executed several thousand Muslim men and then accumulated their bodies into mass graves around the area, these events occurred in TV news on the ground of US intelligence officers who used satellites to monitor them from afar. But what kind of evidence are such tele-visual electronic or digital signals, brought as an event on the television screen? As Paul Virilio repeatedly emphasized, photographic, cinematographic, electronic and digital cameras "see for us." Media scholar Lisa Parks adds the extra-terrestrial point of view: Satellites occupy a position that no human eye can ever replace - a non-human, unearthly position indeed, the media-archaeological gaze.[294]

Applications, and Implications, Berkeley / Los Angeles / London (University of California Press) 2011, 323-333

291 Joel Avirom / Jason Snyder, James Cameron´s Titanic, foreword by James Cameron, New York (Harper Perennial) o. J., xii

292 "Daß Maschinen kein Empfinden haben, bedeutet in diesem Fall eine große Hilfe." Sandra Kegel, Auf der Suche nach den verlorenen Kindern, in: Frankfurter Allgemeine Zeitung, February 20, 2001, 56

293 A derivation contested by Edwin D. Floyd, The Sources of Greek "(H)Istor" "Judge, Witness", in: Glotta LXVIII (1990), 157-166

294 See Lisa Parks, Cultures in Orbit: Satellites and the Televisual, Duke University Press 2003

Archive, culture, memory, entropy, Internet, storage-to-transfer

Media archaeology not only analyzes media culture in a non-anthropocentric way; it takes the presence of the archive itself at face value, not history as imaginary model of processing "past" data. An archivology of media is subversive of the linear causality of narrative history. In accordance with the cultural semiotics developed by Jurij Lotman and the Moskow-Tartu-school, culture is a function of its memory agencies; Lotman has defined culture as a function of its inherent media, institutions and practices of storing and transferring cultural knowledge. Even closer to the physics of culture, media archaeology is concerned rather with data processing than with semiotics, with signals rather than signs.

One function of the technical archive is to take care that cultural and scientific data is being preserved for future retrieval; only the improbable re-use is *informative* since it makes a difference. In Vilém Flusser's somewhat idiosyncratic definition, culture is based on negentropical energy, the un-natural order-keeping (the archive); for media archaeology, with Shannon, entropy is rather the measure of information probability. In Norbert Wiener's *Cybernetics* (1948), information is neither energy nor matter; thus a new kind of "cultural" analysis (not energetical any more) emerges.

Is multi-media memory "archival" in McLuhan's sense that each new medium has the form or the preceding media as its content? The Internet has not yet arrived at its own media-specific memory form. Data banks organized by the World Wide Web is not about content, but rather a transversive constellation of communication. Without content, there is no need for memory; "cyberspace has no memory".[295] Only data which are provided with addressable metadata can be accessed in the techno-cultural archive[296]; in the case of the Internet, this archival infrastructure itself becomes temporally dynamical with the need for *access* data of a given moment in a virtual text. Memorial space itself is being replaced by a limited series of temporal entities. Such topologies become readically temporalized, with the archival paradigm being replaced by permanent transfer.

Media-archaeologically seen, cyber"space" is not about images, sounds or texts, but about bits; hidden behind this romantic surface which misleads by metaphors the media-archaeological mapping is to indicate (indexical rather than iconical) the real stream of data: mapping Internet protocols, depending on IP-protocols. Thus any cartographic or mnemotechnical approach is misleading. This opens new horizons for search operations in the Internet: Not just addressing and linking images and texts by alphabetical addresses, subjecting images and sound to words and external meta-data once more (the archival classification paradigm), but addressing digital images down to the single pixel from within, in their own medium, allowing for random search

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295 Christoph Drösser, Ein verhängnisvolles Erbe, in: Die Zeit, 23th June 1995, 66

296 Axel Roch, Adressierung von Texten als Signale über Bilder. Eine Anwendung der Informationstheorie auf Buch und Bibliothek, typeskript (Berlin)

(apparent disorder as alternative source of information as the unexpected) - literally bit-mapping, mapping (by) bits.

Images and sounds thus become calculable and capable of being subjected to pattern-recognition algorithms. The notion of „pattern", after all, is derived from Latin *pater* - a matrix or rather patrix, a patri-archival order. Such procedures will not only media-archaeologically "excavate" but as well *generate* unexpected optical statements and perspectives from an audio-visual archive that can, for the first time, organize itself not just according to tagging by meta-data but according to its proper criteria - endogenic visual memory in its own medium.

What is being digitally „excavated" by the computer is a genuinely media-mediated gaze on a well-defined number of (what we still call) images - media-archaeology instead of iconographical history. This reminds of the color theory of the impressionist school of painting, as analyzed by art historian Max Imdahl in his seminal study *Farbe* (*Color*) from 1987. Its main characteristic is the „desemantization of seeing", freeing the image from its pictorial logic – an archaeological gaze indeed.[297] Media themselves thus possibly become archaeologist.

Beyond the iconicity of visual interfaces there is algorithmic mapping. Against ideological and referential visual cartography, the archaeological gaze is a mapping gaze, as performed by Global Positioning System devices which time-critically implement the Cartesian grid into real space, mathematically instead of iconically, by numbers instead of images. The very term "mapping" is still associated with metaphorization, visualization, aesthetisation, against which stands the media-archaeological idea of the *operative diagram*: conceptual rather than visual, topological rather than geographical, data-based rather than narrative, connective instead of spatial; code (software) rather than surface, numbers rather than images. From location to pure address: „Only what has been stored can be located" - rather *vice versa*.[298] In this sense the Internet generates a „new culture of memory, in which memory is no longer located in specific sites or accessible according to traditional mnemonics, and is no longer a stock to which it is necessary to gain access, with all the hierarchical controls that this entails."[299] Addressability remains crucial for mediated memory. In Platon´s dialogue *Meno* „it appears as if the matter of memory is but an effect of the application of techniques of recall"[300] - *there is no memory*, rather operative functions of address spaces.

Storage versus transfer? Different data cultures

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297 "Entbegrifflichung des Sehens", ibid., 26. See Lambert Wiesing, Die Sichtbarkeit des Bildes, Reinbek (Rowohlt) 1997, chapter „Die Relationslogik des Bildes", 95-117 (112)
298 Harriet Bradley, The seductions of the archive: voices lost and found, in: History of the Human Sciences Vol. 12 No. 2 (1999), 107-122 (113)
299 Howard Caygill, Meno and the Internet: between memory and the archive, in: History of the Human Sciences Vol. 12 No. 2 (1999), 1-11 (10)
300 Caygill 1999: 2

European cultural memory is centered on archival and rather immobile material values (libraries, museums, millenia year old architecture), whereas the Transatlantic US media culture is transfer-based.

Michael Hardt's and Tonio Negri's book on power in times of global communication networks is appropriately called *Empire*. In a media-archaeological analysis of power today, the territorial notion of empire returns to the original meaning of latin *imperium* which rather means reaching out, extension, a dynamic transfer.

The US Federal Archives do not simply store documents away in an old archival privileging of secrecy, but care for a memory imperative, a very mobile offering of heritage to the public, even advertising to make this memory circulate. If there was no copyright, every online user might take advantage of the fact that in digital networks the old separation between archival latency and present acutalization of information has already collapsed.

"Counting by numbers" (instead of narrative): media archaeology

Media "archaeology" enacts a kind of mathematised stratigraphy (the Harris matrix model) - in techno-cultural sedimentation which is neither purely human nor purely technological, but literally inbetween: symbolic operations which turn the human into a machine as well as they can be performed by machines. Once numbers were abstracted from material things and could then be re-implemented in matter again, as *calculi*, as has been discovered by the archaeologist Denise Schmandt-Besserat for almost pre-historic tokens in the ancient Mesopotamean cultures which were included in a sealed clay volume, with their value imprinted on the surface - an archaic, pre-technological archive of numbers.

Today, computing re-materializes such abstractions from within integrated circuits. Technology, according to Martin Heidegger, is more than instrumental, it transcends the human.[301] There is a mathematical layer inbetween: "Real is only what can be measured" (Max Planck); data come into existence only by the very act of measuring, be it by human physiological senses (which operate in discrete frequencies) or by measuring apparatuses. Such record-making devices turn virtual latency into single-valued actualities - which means that measuring media are generating worlds, by data-giving, or more fundamentally, by turning undecided states into countable data at all in the very act of measuring as act of drawing a destinction.[302]

Counting is related to telling, but in an antogonistic way. When it comes to the question of memory in the age of digital computing, according to Lev

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301 "Das Eigenste der modernen Technik ist kein bloß menschliches Gemächte": Martin Heidegger, Überlieferte Sprache und technische Sprache [lecture 1962], St. Gallen (Erker) 1989, 19

302 "Die Natur wird daraufhin gestellt, sich in einer berechenbaren Gegenständlichkeit zu zeigen (Kant)." Heidegger 1962/1989: 17

Manovich[303], the data model is becoming primary, dictating the narrative; the database (which is "archival" by nature) inverts the relation between *paradigma* and *syntagma*. Archival information refers to the media archaeological mode, whereas narrative belongs to media historiography. Digital narrative, on the techni-infrastructural (not interface) level, is linked to discrete mathematics. Whereas narrative (according to Gotthold Ephraim Lessing's *Laocoon* theoreme of 1766) once was a time-based art like peotry, literature and theatre, nowadays time is organized by technologies.[304] Walter Benjamin 1936, in his essay *Der Erzähler*, states that experience, when cut off from epic tradition, can not be communicated any more in a narrative way. When heterogeneously juxtaposed, information has to be immediately consumed, at once. Realtime analysis belongs to computing and signal processing and is not narratable any more, subject(ed) to the time-critical instant (the *Augenblick*) - while a narrative is extensive interpretation. Henri Bergson insisted on human consciousness of durable time against the chrono-photographical registering of temporal processes. Today, media archaeology corresponds with such mathematical time, and indeed deals with the crisis of phenomenology and its subjective notion of the "inner sense of time" (Edmund Husserl).

From a media-archaeological view, a computing culture deals with calculating memory, which makes sense with a pun in German (just like in other languages): *er/zählen* (narrate / count). Narrative means as well "to go through" in detail, to give an account of - which can be recounting in detail, describing, even listing. "Narration is assimilating information and retelling it."[305] But knowledge communication does not necessarily require narrative. The computer reminds of an opposite option of commumication: Leibniz´ dream to communicate by mathematical formulas, in symbolic language (*characteristica universalis*).

Mediated memories and cultural records

A term like "mediated memories" is tautological. Memory, according to G. W. F. Hegel, is always already technical, a framework for storage; whereas "remembrance" (*Erinnerung*, as the German term implies) refers to a kind of "interiorized" activity which needs to be individually or culturally addressed.

Cultural records that today comprise memory like textual libraries, film, music, and data banks have always been bound to archival media; these media

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303 See the chapter "Data banks as symbolic form", in: Lev Manovich, The Language of New Media, Cambridge, Mass. (The MIT Press) 2001

304 "Zeit wird durch Technologien organisiert": Paul Virilio, Technik und Fragmentierung, in: Karlheinz Barck / Peter Gente (ed.), Aisthesis. Wahrnehmung heute, Leipzig (Reclam) 1990, 71-82 (71). See Dieter Thomä, Zeit, Erzählung, Neue Medien, in: Mike Sandbothe / Walther Ch. Zimmerli (ed.), Zeit - Medien - Wahrnehmung, Darmstadt (Wiss. Buchges.) 1994, 89-110

305 Catherine Levison, *Narration*: http://www.angelfire.com/wa/beeme1/page2.html

literally "govern" (cybernetically) the ways in which humans remember, territorialize and reconfigure the past. The archive itself is a storage medium; so far in occidental culture, though, narrative has been the primary mode of processing archivally stored data in the name of history, which on the surface of so-called multi-media continues in the form of stories (even in computer games, though in fragmented ways). Media-archaeological analysis, on the contrary, does not operate on the multi-media level. Taking account of the fact that all so-called multi-media is radically binary values, digital data processing is undermining the separation into the visual or auditive or textual or graphical channel which on the surface (interface) translated data to human senses. Therefore an archaeology of operative media is not looking for the metaphorical discursive impact of technologies, but reconstructs the generative matrix created by such dispositives. Kircher´s term for his machine to automatically compose music is not by coincidence called *arca*, which is the old name for "archive". In Foucault's updated sense, *l'archive* for Kircher is the generative set of rules which algorithmically produce the music like nowadays programming with software libraries such as SuperCollider.

Instead of asking for cultural memory and the archive on the surface level in discourse, the question of the generative, Foucauldean *l'archive* behind cultural production arises. Media archaeology, different from Cultural Studies, concentrates on the material genealogy of apparatuses which are imbedded within "the archive" as condition of techno-logical knowledge, in the sense of a mathematical rereading of Foucaults *Archaeology of Knowledge* which does not only deal any more with written texts, but with numbers as well, reminding that at the very orgin of the vocalized Greek Alphabet the single letters (*stoicheia*) were used for numers as well (Pythagoras), counting in an "elementary", discrete way.

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.

REFRESHING MCLUHAN

"Media ecology" with McLuhan

Cultural knowledge has resulted in technologies which develop into autonomous systems. Apparently, Marshall McLuhan has been anticipating the current issue of "media ecology" not in the sense of environmental damage but in its cybernetic sense, with his diagnosis of the electic 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".[306] McLuhan's focus, though, is on "the phenomenology of media broadly defined

306 Marshall McLuhan, the Medium is the Massage, New York / London (Penguin Books) 1967, 26

through perception"[307], while the approach by radical media archaeology is distinct from such anthropocentric perspective with its focus 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."[308] But while being brilliant in the diagnosis of macro media infrastructures, McLuhan failed in investigating its micro-infrastructural mirror, 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."[309]
So far McLuhan's diagnosis. The 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 wholehartedly 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 galaxis. 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 at unease with media arts

McLuhan's one day in the recording studio for producing the experimental record *The Medium is the Massage* apparently left him intellectually

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307Michael 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
308 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)
309 Marshall McLuhan, The Planet as Art Form. Interview with David Frost, The American Broadcasting Corportation, 1972; marshallmcluhanspeaks.com/interview/1972-the-planet-as-art-form, quoted after Gottlieb 2017

untouched.[310] The philospher 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. Even if McLuhan identified artists being the radar sensors to the changes induced by new technologies[311], McLuhan performed not as an artist, but as a true academic, with its predominant code of verbal and literary expression. If we stay with the letter, McLuhan is called 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 wiriting from entropy. 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.

A parallel case is Nikola Tesla where it is sometimes difficult to keep his serious inquiry into electric engineering distinct from the mystic and para-psychologic discours attached to his name - for which Tesla partly has to be blaimed himself. Therefore media-archaeological reading tries to resist aesthetic imagination, in order to read Tesla against Tesla.

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 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.

Quoting and showing McLuhan's photographies, audio and video recordings, results in a prosopopoietic delusion, the realm of signal recording which is 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

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310 As remembered by his son Eric McLuhan, quoted by Michael Vazquez in the booklet accompanying the re-issue of the record, FDW7711-LP (orig. 1968 Columbia LP CS 9501)

311 Baruch Gottlieb, Towards a Reasonable Ecology among the Media themselves, Royal Academy of Art, The Hague, September 2017, Den Haag (West) 2017

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.

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.[312]

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 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.

DISRUPTIONS. MEDIA STUDIES (BERLIN STYLE)

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312 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

Two waves of German Media Studies close to technology

A first school of "Medienwissenschaft" in Germany arose in the 1970s at places like the Technical University in Berlin, heavily inspired by the epistemology of cybernetics and by the British Cultural Studies with its *methodological* focus on mass media effects as a "cultural form"[313]. Friedrich Knilli there acquired a costly AMPEX 1000A Two-Inch-Tape based video recorder, since for "live" television programs to be academically (that is: slowly) analyzed it required its recording for deferred and time-axis-manipulated replay. Video recording thus turns out as a technological *a priori* for analyse which makes Television Studies (just like the emergent Film Studes) into a scientific method (Fernseh*wissenschaft*).

It has since been Friedrich Kittler who became the discourse-generator of a second generation of the German way to study media "by focusing on the material and technical aspects of their operation - [...] the cornerstone of the materialist approach now widely referred to as German media theory"[314]. Characteristic for that approach is that it takes both the materiality and the mathematics (logics) of (especially computaitonal) media into account - a litteral interpretation of techno/logy as being derived from ancient Greek *techné* and *lógos* (which is not just words for communication and discourse but numerical ratios as well).

Media is both physical or artificial techniques of communication. Computing transforms cultural artefacts into digitized data, rendering them to networking and interaction and thereby creating new cultural practices. Media are being treated within a decisively academic analysis which keeps their epistemological reflection open for future transformation.

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.[315]

Sigmund Freud's notion of the Unconscious (the "psychischer Apparat") somewhat antedating the French Apparatus approach (Baudry on the cinematic *dispositif*).

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313 See Raymond Williams, Television. Technology and Cultural Form, London 1975

314 Rory Solomon, Last in, first out. Network Archaeology of / as the Stack, in: Amodern 2: Network Archaeology (2013), *online* http://amodern.net/article/last-in-first-out (accessed October 2013)

315 Kapp himself later emigrated to the USA; so far there seems no archival evidence for a direct influence of Kapp on McLuhan. An intermediary is Lewis Mumford, xxx

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 epistemolgical 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. just like by the neighbouring French post-structuralists (Lacan, Foucault, Derrida).

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

Parallel to the emergence of "Medienwissenschaft" (written in singular) as a proper academic discipline in German universities, "Kulturwissenschaft" arose as a field of research inspired by Aby Warburg et al.; especially with the re-organization of Humboldt University after the fall 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 interdiscipinary "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"[316]. 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*"[317]. 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.

316 Böhme 1989: 30
317 Wolfgang Frühwald, Geisteswissenschaften heute. Eine Denkschrift, Frankfurt/M. (Suhrkamp) 1991, 156

"Understanding media" with ears

While most German media studies have originated either from philology (Germanistik) or from Theater and/or Film and Television studies, there has been a neglect of the auditory channel of communication. Finally, the special alliance between musicology and media archaeology[318] at the Humboldt University Institute for Musicology and Media Science leads to a special emphasis on "sonicity" as its structural link: time-based signal processing.

The different meanings of "communication" in (German) Media Theory

German Media Theory is characterized by its combination of close analysis of media technologies with deep philosophical questioning of such evidence. It rather stays close to the signal than to cultural and communicative semiotics. This peculiar mix of fascination with engineering together with epistemological reasoning leads to a radical shift of focus of attention to communication not between humans but within machines. 99 % of the "media event" occurs *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 archival lectures 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."[319]

Media-archaeological investigation does not aim at reconstructing the relation between communication studies and German media theory in terms of history of academic discourse but rather concentrates on the epistemological points of "dis/agreement". Moments of radical divergence is Shannon's "Mathematical Theory of Communication" (1948) as wel as McLuhan's "understanding" of

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318 See Friedrich Kittlers monumental work on *Musik und Mathematik*, resulting in the volumes *Aphrodite* and *Eros* , Munich (Fink) 2006 / 2009

319 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. See Roch 2009, chap. 2.4 "Statistik gegen Geometrie", 61 ff.

media (1964) which started in communication studies but turned it upside down into a core moment of emerging Media Studies proper. In addition, the "take-off" of German Media Theory has been a radical technological *grounding* of French (post-)structuralism (Lacan, Foucault). The "Berlin school" develops a radical media archaeological and -epistemological approach, which rather enhances the incommensurability between communication and media studies.

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 the technomathematical one - in the sense of the mathematical square root which is the symbolic expression of the verbal notion of *arché*).

The media-epistemological focus is on what unfolds *within* that bracket (*epoché*) which escapes phenomenological, anthropocentric communication or "media" 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 und listeners - because he wanted to be able to leave the recipient out of the mathematical theory altogether."[320] True *media*-understanding gets epistemologically attuned to the technological inbetween which has transsubstantiated from Aristotle's *to metaxy* as physical channel of communication (water, air) to technologically adopted electro-physicality, different from the media-phenomenological focus on interfaces as human media experience.

While German Media Studies (even media "science") emerged rather abruptly in the final quarter of 20th century, it has no prehistory but rather diverse epistemological roots in German thinking like Kapp's *Philosophie der Technik* 1877, Benjamin's approach to technical reproduction (1936), Heidegger's concept of the technical "turn", while at the same time being heavily influenced by Anglo-American theory of media engineering (Turing, Shannon) and French thinking like Lacan's equation of the human subconscious with the machine, and Foucault's rigid discourse analysis.

While communication studies with a sociological impact have been prominent in 20th century academic research (represented in the German speaking world by the Frankfurt School "Critical Theory" with Adorno and others), German media theory has emerged from the necessity to answer material questions rarely posed by communication studies. The "speculative nature" of "German theorizing" (as expressed in the cfp) rather links it to Object-Oriented Ontology than to manifest media content research. German media theory starts from a different concept of communication: understood not in the sociological but engineering sense (Claude Shannon 1948), with "information" being a mathematical ratio rather than a semiotic negotiation of discourse.

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

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320 Friedrich Kittler, Observations on Public Reception, in: Radio Rethink. Art, Sound and Transmission, ed. by Daine Augaitis / Dan Lander, Banff (Walter Phillips Gallery) 1994, 75-85 (75 f.)

of meaning would), but rather to the situation as a whole"[321]; mathematical calculation mesaures the temperature of communication, that is: the amount of freedom of choice in selecting a message (its entropy).

Information theory arose under the pressure of engineering needs: the efficient design of electronic communication devices (telephone, radio, radar, and television) depending on achieving favorable `signal-to-noise ratios´. "Application of mathematical tools to these problems had to wait for an adequate formulation of `information´ as contrasted to `noise´. If noise is defined as random activity, then information can be considered as order wrenched from disorder; as improbable structure in contrast to the greater probability of randomness. With the concept of entropy, classical thermodynamics expressed the universal trend toward more probable states [...]. Information can thus be formulated as negative entropy, and a precise measure of certain classes of information can be found by referring to degrees of improbability of a state."[322]

Message or noise?

If communication is understood in cybernetic terms, it is not restricted to bridging space but opens a temporal horizon, allowing for anticipating the future by predictive algorithms: "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."[323] This scenrario is not about mutual understanding but about signal circulation in coupled systems, be it man-man, man-machine, or machine-machine(s). Its media-archaeological primary scene has been the Anti-Aircraft Prediction in Second World War and the Anti-Missile program in the Cold War, as developed in parallel lines by Norbert Wiener (with Bigelow) and by Claude Shannon.[324]

Shannon developed techno-mathematical enemy aircraft movement anticipation, where the human factor (the pilot's intentional manoeuvers) is superseded and limited (corrupted) by the mechanical behaviour of the airplane and other physical parameters[325]

Norbert Wiener conceived his applied time series analysis in the context of tactical *anti-aircraft prediction*. In this model the real die position of the enemy

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321 Weaver 1949 / 1963: 9

322 Heinz von Foerster / Margaret Mead / Hans Lukas Teuber (eds.), Cybernetics. Circular causal and feedback mechanisms in biological and social systems. Transactions of the Ninth Conference March 20-21, 1952, New York, N. Y., New York (Macy) 1953, "A note by the editors", xiii

323 Winfried Nöth, Handbook of Semiotics, Stuttgart 1990, 178

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

325 See Axel Roch / Bernhard Siegert, xxx, in: Schade / Tholen (eds.), xxx

airplane at the temporal moment *t* is considered the "message", whereas registered deviations represent "noise".[326]

The logos of the machine: Non-human communication

Media archaeology is both a research method in media studies, and an aesthetics in media arts. It addresses the non-human procedures which happen and / or "communicate" in media technologies themselves.

The term "non-human" is taken here in a double sense: First of all, it hypothetically means the point of view of the machines, being a kind of "inhuman hermeneutics". And second, as can be demonstrated by the use of the term "communication" in Claude Shannons "Mathematical Theory of Communication" from 1948[327], it relieves the notion of "information" from all semantic meaning. In that sense, a transmitter of radio waves "communicates" with the radio receiver, or computers communicate in-between in the Internet. Not the quality of information counts, but it is taken as a quantitative measure, both in the statistical sense and in information theory.

"The word *communication* will be used here in a very broad sense to include all the procedures by which one mind may affect another. This, of course, involves not only written and oral speech, but also music, the pictorial arts, the theatre, the ballet, and in fact all human behavior. In 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)."[328]

Marshall McLuhan (1964) rather analyzed the media technological massage than its discursive "content" which he even dismissed as diverting critical attention. 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 logical techniques.

Bertolt Brecht's "radio theory", around 1930, clearly underlined that it takes technical intervention to prevent the radio from becoming a passive consumer device; only by activating the feedback channel, radio can be turned into a literal "communication device".

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326 P. R. Masani, Norbert Wiener 1894-1964, Basel / Boston / Berlin (Birkhäuser) 1990, 186

327 Claude E. Shannon, The Mathematical Theory of Communication, in: Bell System Technical Journal 27, Juli/Oktober 1948, 379–423 / 623–656

328 Warren Weaver, Recent Contributions to the Mathematical Theory of Communication, in: Claude Shannon / same author, The Mathematical Theory of Communication, Urbana (University of Illinois Press) 1964, 1

Audio communication, at the Berlin Technical University, therefore explicitly underlines: "An der Technischen Universität Berlin hingegen befasst sich die Kommunikationswissenschaft mit den naturwissenschaftlichen Grundlagen von Sprache und Musik."[329]

Even without any human being involved, communication takes place: "the procedures by means of which one mechanism (say automatic equipment to track an airplane and to compute its probable future positions) affects another mechanism (say a guided missile chasing this airplane)", Warren Weaver declares in his "Introductory Note on the General Setting of the Analytical Communication Studies <sic>".[330]

Almost by techno-logical necessity, Thodor W. Adorno's analysis of music in radio culture *Current of Music*, which stays close to the signal, once became incompatible with the communication 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.[331] 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. Digitzation radically multiplied channels for transmission, which implies a radical transformation in the ontology of communication: its mathematization and algorithmization.

Paul Baran and Donald Watts, in 1963, develop *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 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

329 http://www.tu-berlin.de/zuv/asb/faecher/komm/komm.html
330 In: C. E. Shannon / W. Weaver, The mathematical theory of communication, Urbana, Ill., 1963, 3-28 (3)
331 D. Q. Innis, A Note on Communication and Electromagnetic Resources, in: Harold A. Innis, The Bias of Communication, Toronto / Buffalo / London (Univ. of Toronto Press) 1995, Appendix I, 199-202 (201f)

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 "analogue" model of mediated communication which has been channel-based transmission (tele-communication in the spatial sense, tradition in the temporal sense) is currently under-tunneled 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 communiation actually takes place: its material agencies. In the binary code of earely 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 becames 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."[332] 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 favor 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"[333], transcedning communication in the narrow human sense.

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

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332 David A. Mindell, Between Humans and Machine. Feedback, Control, and Computing before Cybernetics, Baltimore / London (Johns Hopkins University Press) 2004, 112
333 Mindell 2004: 107

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 espistemological 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"[334]. McLuhans 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.

Early 20th century artistic avantguardes have been triggered by media technologies such as chronophotography and film. As has been pointed out by Clement Greenberg in his writings on art (and later by Michel Foucault in his interpretation of Manet), modernist painting itself has discovered the grounding materiality of the rectangular canvas as the principal message. According to McLuhan who developed this insight further, it is the media-archaeological task of the artist to un-cover such a ground (like according to Martin Heidegger it is the philosopher's task to reveal forgotten ontological substrata), and to communicate these insights in anticipation of what only belatedly becomes apparent to society.

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.[335] 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."[336]

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334 Published in: Journal of Advertising Research vol. 2, no 1 (February) 1971, 3-9
335 Interfaces, though, may be treated different from traditional surfaces, since they represent a technical coupling.
336 Marshall McLuhan / Eric McLuhan, Laws of media. The new science, Toronto (University of Toronto Press) 1988, 63

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 Communication". McLuhan's critical, almost satirical reading of the Shannon diagram as a simple linear sender/reveiver-relation reveals his essential ignorance of the mathematical resoning 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.

McLuhans critical comment on Shannon's communication diagram is a desastrous 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.[337] "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*"[338] - 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'."[339]

Can such an intepretation 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."[340]

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337 As quoted in: Peter Bexte, Cadillac und Gebetmatte. McLuhans TV-Gemälde, in: Derrick de Kerckhove / Martina Leeker / Kerstin Schmidt (eds), McLuhan neu lesen. Kritische Analysen zu Medien und Kultur im 21. Jahrhundert, Bielefeld (transcript) 2008, 323-337 (335)
338 Marshall McLuhan / Eric McLuhan 1988: 86
339 Tony Schwartz, The responsive chord, Garden City, New York (Anchor books) 1974, 19
340 Schwartz 1974: 24

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 epoque 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 symbolically transformed from distinct hardware to software, thus: software formats.[341]

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.

By-passing the human-machine interface

Media archaeology as "critique" does not proceed by analysis of media content (which is the task of media sociology and communication studies) but means critique of the kind of ideology which is inherent in hard- and software, in the best tradition of French *Apparatus* theory (Baudry et al.).

To apply this to audio media, especially to short wave AM radio, the apparant dichotomy 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.

As a compromise between content-orientated mass media studies and hard core media archaeology, media theorists like Lev Manovich created "software culture" studies. Manovich finds it impossible now to separate between the cultural and the technical level in or rather "on" the computer; let us, here, interpolate the term "cultural engineering" which links both.

The recent debate about the US-American PRISM data surveillance system reminded of the necessity for Time-Critical Media Studies in both senses of "time-critical": in the sense of political analysis and in the most presice "forensic" (Matthew Kirschenbaum) hard- and software sense which is the media-archaeological level of analysis. Obviously, PRISM refers to the fiber glass cable which links Contintental European to British and US-American data transfer. "Big data traffic", as expression, has replaced "mass media communication". Such a cable can "read" in terms of symbolical (binary) data processing.

"Software studies" (Matthew Fuller et al.) does not reduce analysis to discourse, but critically looks at the algorithms and their embeddedness in Hardware structures themselves.

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341 See Stefan Heidenreich, FlipFlop. Digitale Datenströme und die Kultur des 21. Jahrhunderts, Munich / Vienna (Hanser) 2004

Obscuring media technologies: Online communication and "cloud computing" as challenge to Media Archaeology

Current "cloud computing" and mobile media challenge the original technical *a priori* focus on material computer platforms and source code. But different from communication studies of "social media", material media studies insists on "the media artefact at the centre of media-epistmological analysis.

In so-called "social media", the "social" in fact has become a function of nonhuman communication engineering. Even "cloud computing" still requires a close analysis of its underlying hard- and software, such as a reminder of the giant water cooling systems for hot data processing at the Google data centers in the European North.[342] In order not to let terms like "network" slip into pure metaphors, an analysis of its technical and logical infrastructure (which is optical fiber cables and protocols) needs to be as exact as the description of the electronic FlipFlop circuitry, as the very condition for "binary" computing.

Against precise analysis close to the infra-structural data logistics[343], metaphors like the data "cloud" are literally obscuring, "cloudy" in both the thermodynamic and informational sense of entropy. The current fashion of so-called media-ecology puts a veil on the actual technological condition. Only a renewed *enlightenment* will - less allegorically - read the operative diagram of current Information Society like it used to open the black box of individual technologies so far. The *protocols* (Alexander Galloway) of Internet traffic are still there to be deciphered with media-philo*logical* competence in its most ancient sense of *logos*, that is: alpha-numerically.

While hardware- and code-focused knowledge of ubiquitous computing is still vital, what additionally has emerged is the necessity to identify the operative temporality of the World Wide Web, like the time-critical "ping" signal and UNIX time, as well as a neo-cybernetic model of the coupling of humans to algorithmic devices. The everyday cyborg is loosely coupled to communication devices, while s/he (or "it") becomes tightly coupled to microchip implantations. The tablet computer or smart phone (the neo-German "Handy") is not simply *ready-to-hand*; like Martin Heidegger's "hammer" (in *Time and Being*) any more; computational communication devices in the permanent "online" mode rather subject the human to their proper, chrono-technical regime.

MEDIA ARCHAEOLOGY AS SPECIFIC METHOD

Introducing Media archaeology

Media Archaeology is meant to indicates alternatives models of thinking the being of media in (emphatic) time, thus: an alternative to linear historiography

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342 Jennifer Holt / Patrick Vonderau, "Where the Internet Lives": Data Centers as Cloud Infrastructure, in: Parks / Starosielki (eds.) 2015: 71-93
343 As argued in Shannon Mattern, Deep Time of Media Infrastructure, in: Parks / Starosielki (ed.) 2015: 71-93 - even if the author traps into the metaphors of the archaeological "excavation."

of technology. No narratives of media origins in the historic sense, but rather another level of media tempor(e)alities: governing principles, archaic essentials - such as the *enduring* infrastucture of radio or the recursive return of the "alphabet" in the digital age which 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.

"Media archaeology" encompasses a variety of approaches to media. Media archaeology, first of all, is a method of media analysis, adressing the structural level of media practice (which Foucault named as the governing laws of media, such as Internet protocols or the von-Neumann-architecture of digital computers). Furthermore, it is an aesthetics: the "cold gaze" of distanced understanding but "close reading" of technological circuits. 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, f. e.). Media archaeology is certainly not a nostalgia for the analogue (unless this is kept private), but extends to an art form (Paul de Marinis, Carsten Nicolai) which reveals the technical basics of media as opposed to the intangible hiddenness of micro-chip based media today (reduced to the max).

Media archaeologiy is a form of generating knowledge, with the media themselves as active agents like digital signal processing which restored early "phonographic" records back to sound, speech and music again (*Lautarchiv* Berlin). Linkes to media archaeologiy is the gesture of "open source" (de-constructing hardware): not in the sense of public usage of source codes in programming, but in the sense of dis-mantling media from their designed enframing, un-clothing).

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

"The cold gaze" is a description of the media-archaeological aesthetics indeed, somewhat close to Ernst Jünger's photographic media aesthetics. Admittedly, German pre-war engineering culture still lurks through (just like in Ernst Jünger's aesthetics of the photographic "cold gaze"), and the Heideggerian ways of fundamental re-thinking of terms like technology. Today, I would add to the "the cold gaze" the unpassionate ears (listening to the "sonic", that is: sound emerging from technomathematical media).

Media studies ask for a special mixture of technological competence and epistemological reflection. One should indeed expect for a researcher and critic of media to know exactly what is the electro-magnetic induction or TCP/IP &

'Routing'.[344] But of course academics do *not* read German media thoeries to learn technological knowledge: "Was jene metaphysischen <?!> Schriften sattdessen so anregend macht, ist die Selbstverständlichkeit, mit der darin Medientheorie in Philosophie, Literatur und die Geisteswissenschaften im Allgemeinen eingebettet sind" <ibid.>.

There is a certain technologistic, that is: machine- and code-centered school of media studies indeed.[345] 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, 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."[346] 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 as much in Foucault's definitions[347] as it is connected with Marshall McLuhan's non-contentist media analysis. Whereas Hansen in his discussion of what is an "image" in the age of new (that is, electronic and digital) media, in an explicit Bergsonean tradition insists on the coming-into-being of the mediated image in the "enframing" acts of the human bodily cognition only[348], "posthuman cultural studies"[349] as radical media archaeology takes the point of view of the machine itself, with "radical" to be interpreted in two ways: going to the roots (which is the archive), to the beginnings (less in the sense of historic causality but temporal originality: the opening and generation of the time-critical *momentum*[350] and of temporal horizons), and in the techno-mathematical

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344 Geert Lovink, Der Verbleib der deutschen Medientheorie", in: same author, Zero comments. Elemente einer kritischen Internetkultur, Bielefeld (transcript) 2008, 129-145 (xxx)

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

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

347 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

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

349 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)

350 See Axel Volmar (ed.), Zeitkritische Medien, Berlin (Kulturverlag Kadmos) 2009

sense (square root) as the basic conditions of media hardware and algorithms (software).

This signal-based approach is different from the rather semiotic than approaches of Cultural Studies. There has been a translation barrier for relevant texts so far, different from the world of techno-mathematical engineering which would cross-culturally wire artefacts into standard operation. What looked like an antithetical configuration between German hardware-orientated and and Anglo-American socially and culturally orientated media studies for a long time, nowadays seems "sublated" by a Hegelian trick ("List") of media-theoretical reason. So-called software studies[351] and a refreshed materialist (forensic) approach[352] links both cross-Atlantic schools.

Micro-technological research on signal transfer should not strictly be 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. Inbetween-positions exists as well, as expressed in Erkki Huhtamo's book *Illusions in Motion. A Media Archaeology of the Moving Panorama and Related Spectacles* - a kind of archaeology of *pre-cinéma*.

With no overall consensus about its definition, methods, tools, or even its field[353], there are different ways of doing media archaeology, much of them "re-mediating" new media (theories) with previous ones recursively.[354] At the same time a Foucault-driven media archaeology accentuates the discontinuities.

Media archaeology is aware of discontinuities in media cultures (as opposed to the reconciliating narratives of cultural history). The German "school" that has emerged emphasizes material factors as prime movers of media history. From writing surfaces, and inscriptions on phonograph cylinders or celluloid film to machine architectures and computer code, "Kittlerian" 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 towards a central artefact in occidental cultural engineering, the wheeled clock, which 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 analyzes the mechanisms of

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351 See Matthew Fuller (ed.), Software Studies. A Lexicon, Cambridge, Mass. / London (MIT Press) 2008; Jussi Parikka, Digital Contagions. A Media Archaeology of Computer Viruses, New York et al. (Peter Lang) 2007

352 See M. Kirschenbaum, Mechanisms. New Media and the Forensiv Imagination, Cambridge, MA (The MIT Press) 2008

353 See Erkki Huhtamo and Jussi Parikka, An Archaeology of Media Archaeology, in: *Media Archaeology: Approaches, Applications and Implications*, eds. Huhtamo and Parikka, Berkeley / Los Angeles (University of California Press), 2011

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

time-keeping, and thereby is less concerned with the traces of ancient religious practices embedded in the history of time-keeping technologies but its continuous effect in the present. What is paramount to consider is the *dis*-continuity between the history of religious time-keeping and the evolution of time-based media. Media archaeological analysis, different from the "cultural study" of religion and technology, does not to bring them closer together, but rethink the terms on which they must remain separate: the oscillating clock and its progressive detachment from its original locus in the monasteries of medieval Europe.[355]

Another case is optical media : "One may still wonder who its real protagonists have been - the machines <..> or the people who created them, exhibited them, consumed them, and fantasized about them? The answer is an oxymoron: the *clue* of the story is their increasingly complex and contentious relationship. <...> Friedrich Kittler tells a very different story <...>.[356] 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. What Kittler (before his re/turn to ancient Greece) provocatively calls "so-called humans" rarely appear in his "media studies without people."[357]

Media archaeology argues against the presupposition of an primordial binding of media to the social and cultural spaces they occupy.[358] In Huhtamo's version of media archaeology, although one must understand hard technological facts, "it may be even more important to grasp the discourses that envelop them and mold their meanings in unique cultural circumstances" (op. cit.). But beyond the opposition between Cultural Studies and German Media Theory[359], a new generation on both sides interlaces (to use a term from electronic imaging) both approaches[360], leading to a kind of relegation between cultural and media epistemology which acknowledges both the nonhuman agencies (Bruno Latour) and their discursive dependencies.[361]

Where do technological continuities derive from? Just like Manovich's archaeology of the computer screen[362], Mark B. N. Hansen underlines in *New*

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355 See Jeremy Stolow (ed.), Deus in Machina. Essays on Religion and Technology in Historical and Cross-Cultural Perspective, xxx

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

357 John Durham Peters, "Introduction: Friedrich Kittler's Light Shows," in Kittler 2010: 5

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

359 Winthrop-Young 2006: 88

360 See the introduction of the editors in: Hall / Birchall (eds) 2006, 1-28, and Caroline Bassett, Cultural Studies and New Media, in: ibid., 220-237

361 As an exemplary study from the German side see Cornelius Borck, Hinrströme. Eine Kulturgeschichte der Elektroenzephalographie, Göttingen (Wallstein) 2005; same author: Electricity as a medium of psychic life. Electrotechnical adventures into psychodiagnosis in Weimar Germany, in: Science in Context vol. 14 (2001), 565-590

362 Lev Manovich, Towards an Archaeology of the Computer Screen, in: Cinema Futures: Cain, Abel or Cable?, edited by Thomas Elsaesser / Kay Hoffmann,

Philosophy of New Media: no technological imperative leads from digitization 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 adressable, numerical fragments. It is not a frame and new media are not constrained by the rectangular frame. Cinematic interface may thus be seen as a cultural lag, rather than a technological imperative."[363]

But the matrix is a mathematical figure like the rectangular magntic core memory for storing an image in early digital computers.

Manovich interprets the possibilities of such interfaces as prefigured already by the cinematographic avant-gardes of the 1920s, in their experiements with jump cuts, animation and collage. According to Manovich, the avant-garde anticipated digital aesthetics.[364] But let us have a close look at a magnetic core memory. It is *not* just aesthetic strategies which became embedded in the commands and interface metaphors of computer software. The modernist strategy of collage reemerged as a 'cut and paste' command, the most basic operation one can perform on digital data."[365] The so-called "post-cinematic image" is different from the cuts and jumps and interactivity in computer games.[366]

The language of so-called new media[367] (which obviously refers to digital media driven by the binary code) is not just what interfaces offer to the human user, it is as well machine language on the operative level of computer programming. Such a perspective, without saying, is less discourse-orientated than the "social media" approach.

How could one otherwise explain that television broadcasting as a mass medium emerged after Second World War both in Western and in Eastern Block countries on the same, almost identical technological basis (both derived from pre-war developments)? Why was there not something like a specific "socialist" (even "Marxist") technological variance? The articulation of ideological differences was rather reduced to the content of the television programs.

While for many years there has been a translation barrier for relevant German or French techno-philosophical texts to reach the anglophonic world, the world of techno-mathematical engineering which cross-culturally wires artefacts into

Amsterdam (Amsterdam University Press) 1998, 27-43
363 Kjetel Jakobsen, Anarchival Society, in: Eivind Rossaak (ed.), The Archive in Motion, Oslo (Novus) 2010, xxx
364 Lev Manovich, The Language of New Media, xxx 2001, 78 f.
365 Lev Manovich, WHAT IS DIGITAL CINEMA? http://www.manovich.net/TEXT/digital-cinema.html (accessed January 2011); see idem, Engineering Vision: from Constructivism to the Computer (The University of Texas Press), forthcoming
366 See xxx, in: Benjamin Bigl / Sebastian Stoppe (Hg.), Playing with Virtuality. Theories and Methods of Computer Game Studies,Frankfurt/M. (Peter Lang 2013, xxx-xxx
367 Lev Manovich, The Language of New Media, Cambridge, Mass. (The MIT Press) 2001

standard operations almost immediately. Nowadays, so-called software studies[368] and a refreshed materialist (forensic) approach[369] links both cross-Atlantic schools.

Further definitions of media archaeology

Media archaeology is the complementary method to media phenonemology. It does not look at media on the level of their surface effect on humans (interfaces), but rather uncovers the hidden agenda of technomathematical artefacts, or better: artefactuality, focussing on temporal and time-critical configurations.[370] 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*). The intellectural father of Humboldt University, Wilhelm von Humboldt already differentiated between the "external form" and the "inner form" of language, neologistically conforming with phenotype and genotype and the figure / ground dichotomy as re-discovered media-theoretically by Marshall McLuhan from *Gestalttheorie*.[371]

Media archaeology at first sight is about technological architectures, but it is concerned with media not only on their structural but as well on their *operative* level, thus becoming "post-structural" or "diagrammatic". This post-structural vector (a diagrammatic media theory) places it beyond semiotics and closer to the analysis of signal processing (a signal being the physical representation of a message respectively information *in time* - that is, with time as the variable of functions under analysis).

Technological media themselves have an infolded, implicit knowledge of the physical and mathematical world which differs from human perception. Media archaeology as a doube-faced method here takes the point of view of humans and hypothetically the point of view of media as well. To exemplify it: 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

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368 See Matthew Fuller (Hg.), Software Studies. A Lexicon, Cambridge, Mass. / London (MIT Press) 2008; Jussi Parikka, Digital Contagions. A Media Archaeology of Computer Viruses, New York et al. (Peter Lang) 2007

369 See M. Kirschenbaum, Mechanisms. New Media and the Forensiv Imagination, Cambridge, MA (The MIT Press) 2008

370 "Nicht <...> eine ableitende Begrndung, sondern <...> aufweisende Grund-Freilegung": Martin Heidegger, Sein und Zeit, 15. Aufl. Tbingen (Niemeyer) 1979, 8

371 See Marshall McLuhan / Bruce Powers, The Global Village, xxx, referring to Edgar Rubin and Max Wertheimer. See Edgar Rubin, Visuell wahrgenommene Figuren. Studien in psychologischer Analyse, London (Gyldendalske Boghandel) 1922. For an application see Richard Zakia, Perception, Evidence, Truth and Seeing, in: The Concise Focal Encyclopaedia of Photography, Elsevier (Focal Press) 2008, 239–250 (242)

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"[372] - which pefectly correspondes 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 startet with the electro-mechanical relay resulted in electronic flip-flop circuits first on vacuum tube, then an transistor basis. Different from e. g. *ternary* switching, it is "easier to work in the scale of two than any other, becuase it is easy to produce mechanisms which have two positions of stability; the two positions may then be regarded as representing 0 and 1"[373].

Written and read carefully, there is media *arché*ology. In ancient Greek, *arché* splits into a temporal and a functional meaning: *origin* on the one hand, and *command* on the other.[374] Misunderstandings should be avoided here. Instead of "media archaeology", should I not rather write "prehistory of media"? The term *prehistory* implies a certain teleology that is alien to technology.[375] 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 non-linear modes (as described in René Thom's theory of catastrophy) just as there are electro-dynamic processes which are ultra-sensitive to slightest changes which result in a complete re-organization of the whole system. Theories of history fail when they have to explain non-linear, contingent events in the past[376], such as the sudden break into the Berlin wall on 9th November 1989 when the answer "immediately" ("sofort") by Schabowski corresponded with the immediacy of live transmission in radio and TV.

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.

Media archaeology refers to the past insofar as it adresses the condition of the possibility for current media operations, which means: being (still) at work. 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 Fourier analysis and Markov chains.

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372 Denis Guedj, Numbers. The Universal Language, xxx (Thames & Hudson) xxx, 59

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

374 See Jacques Derrida, Archive Fever, xxx, Introduction

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

376 Ludolf Herbst, Komplexit舩 und Chaos. Grundzge einer Theorie der Geschichte, Mnchen (C. H. Beck) 2004, 213

Media archaeology is not a simplification, but an analytical reduction to techno-logical 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 electrotechnology.

Media archaeology aims at an *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 iin Foucault's sense.

According to the media-archaeological *credo*, technological structures become especially evident in 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 as the *motto* of the Memoirs of John Logie Baird[377] which is a very archaeological insight into first steps of the electro-mechanical television apparatus itself. "In principle, the *televisor* is both simple and ingeniour", comments the brochure accompanying the model kit *The Televisor*, developed as teaching device by the Middlesex University.[378]

What kind of "archaeology"? Media materialism

Just occasionally, media archaeology is a hunting for "dead media" discoveries and reverse engineering such as Semen Karsakof's 1832 design for an "intellectual machine"[379]. Media archaeology describes moments when media themselves, not exclusively humans any more, become "archeologists" of epistemic objects, like practiced in so-called "content-based" image and sound retrieval in media-archival data banks. Somewhat beyond Marshall McLuhan, media are not just extensions of men any more but have become autonomous, beyond body-related cultural techniqes such as religious rituals or hand-writing practices in a broader sense. Media are not just objects of media-archaeological analysis, but as well active "archaeologists" of a different kind of knowledge themselves (understood here in Bruno Latour's sense of "non-human agencies).

While sharing with the classical archaeologicst the attention of the material artefact ("hardware"), the essence of media archaeology comprises the *operative*, processual mode of technological media as well.[380]

377 Television and Me. The Memoirs of John Logie Baird, edited by
  Malcolm Baird, Edinburgh (mercatpress) 2004
378 See www.mutr.co.uk
379 See Wladimir Velminski / W. E., Semn Karsakov: Ideenmaschine. Von der Homöopathie zum
   Computer, Berlin (Kulturverlag Kadmos) 2007
380 At this point, we should pay respect to the so-called "Processual Archaeology" as developed by
   the Cambridge school.

Archaeology, in Michel Foucault's notorious definition, "designates the general theme of a description that 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."[381]

Archaeology in its traditional sense is "indicating the material or substance of which anything is made or consists" (Oxford English Dictionary). 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.[382] 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 presice technomathematical terms. Media archaeology performs a technological micro-epistemology, that is: disovering, analysing and describing the epistemological sparks which spring from the most concrete level of technology itself, such as the delicate circuitry of the electronic saw-tooth signal generator which creates the jumps of single cathode ray lines within a television set in order to achive the impression of a cohrent image for (lagged) human perception at all.[383]

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

While multi-media aesthetics is a surface effect, digital signal processing is its media-archaeological generative law. Let us not forget the techno-mathematical essence of computing, its electric fluidity and switching circuits.

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

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

381 Michel Foucault, The Archaeology of Knowledge, xxx
382 See Walter Falk, Vom Strukturalismus zum Potentialismus. Ein Versuch zur Geschichts- und Literaturtheorie, Freiburg i. Br. / Mnchen (Alber) 1976, 310f
383 See A. J. Klopow, Grundlagen der Fernsehtechnik, bers. und ergänzt v. P. Neidhardt, mit e. Geleitwort von Manfred v. Ardenne, Berlin (VEB Verlag Technik) 1956, chapter 5 (50-99)

(the single letter) transforms into a electro-physical signal.[384] A transformation (or even "transsubstantiation" in the theological sense) takes place. When this passage of symbol into signal takes place, it looses all its semantical referentiality and becomes a coded element within a (physically) real word - loosing "meaning" while gaining "indexicality".

Micro-research

In media-archaeological terms, applied epistemology as micro-research is required. "Open hardware" can be read literally: revealing the hidden structures in hardware, thus undermining the *dissimulatio artis* which is the central trope of techno-rhetorics for media in order to be successful towards humans. In May 2009 the *Micro Research* lab in Berlin[385] offered a workshop on the "Epistemology of electromagnetic waves" (curated by Shintaro Miyazaki); other workshops comprised subjects like the RFID sniffer workshop which led to the practical construction of a simple analog electronic circuit which detects the presence of 13.56 MHz RFID tags which are commonly used in plastic cards in libraries or shops.[386]

Media-archaeology is about the fundamental, the essential, the ascetic, the reductive. In this way, media archaeology is an active examination and questioning of technolgy - "digital forensics" (Kirschenbaum).

Soft media archaeology

The term "media archaeology" is *en vogue* nowadays in media studies, such as in the writings and projects of Siegfried Zielinski, Timothy Druckrey, Erkki Huhtamo and others. Especially Bruce Sterling's "Dead Media Handbook Project" (initiated 1995, conceived for the Internet) cares for the redemption of otherwise forgotten technologies. Zielinski 1996: "[...] media archaeology [...] in a pragmatic perspective means to dig out secret paths in history."[387] A lot of these authors take the term "media archaeology" at face value, almost metaphorically: referring to the "digging out" of forgotten machinic visions of the past, of antique or baroque media design which was never materialized, which has remained a singular effort and which are simply forgotten today.

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-title: *A Collection of many Problems Extracted out of the Ancient and Modern Philosphers: As, Secrets and Experiments in Informatics, Geometry*, Cosmography, Horologiography, Astronomy, Navigation, Musick, Opticks, Architecture, Statick,

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

385 *Micro-research* is the name for an independent research centre in Berlin focussing on the analysis and construction of "open hardware" on the one hand and free software on the other.

386 See: http://shop.marcboon.com/snifferkit.pdf

387 Originally published:7/11/1996, at: www.ctheory.net

Mechanicks, Chymistry, Water-Work, Fire-Works, etc., Wherennto is added, Dead Media.

Choosing by chance (that is: by random access) any of these items, one finds, e. g., the switch-board of an early computer installation in an office. The book is supplemented by scraps of indented paper stripes which apparently is Morse code. What is declared as "dead media" here, in this case can principally be re-enenacted (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. Media archaeology is not a specific form of media history but rather an alternative to the historical discourse itself, just like Fourier Analysis replaces the linear time axis of sinusioidal signals by frequencies.[388]

Different from history and narrative: archaeography

Digitization of paper-based archives from the past not only affects textual criticism and philological research by new options of accessablity and addressability of "big data" strings and by intelligent search algorithms (so-called Digital Humanities) , but as well image and sound collections. Archives themselves - the traditional data-base for historical research - become temporalized by digitization, and born-digital data resulting in streaming archives right in their moment of coming into being. The micro-temporality in the operativity of data processing (synchronization) replaces the traditional macro-time of the "historical" archive (governed by emphatic historical consciousness) - a literal "quantization". The relation of the present to the past thus becomes truly "archival". Archeography practices an alternative form of minimal, serial time-writing (or rather registering), closer to the programming of computing itself. Computers practically transform narrative aesthetics into non-discursive, algorithmic configuration of events. Current culture begins to acknowledge this operativity of digital culture.

Media archaeology's affinity to mathematics

A core element of mathematical analysis of physics is direction.[389] Calculating vectors is an alternative way of expressing what is commonly known as the "evolution" of media.

Media, when taken as physical channels of communication and as technical artefacts which are operated by symbolic codes and streaming data, require to be analyzed in ways different from texts or works of art. The media

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388 See Friedrich Kittler, Draculas Verm 膿 htnis. Technische Schriften, Leipzig 1993, 200
389 Denis Guedj, Numbers. The Universal Language, xxx (Thames & Hudson) xxx, 97f

archaeological theory is such a way of looking at media objects: enumerative rather than narrative, descriptive rather than discursive, infra-structural rather than sociological, taking algorithms (literally) "into account".

The natural way of rendering Foucault's passages on archaeology intelligible (like Foucault's affinity to serial music, notably Barraqué's) is to take the notion of enunciative function at its mathematical face value.[390] This is the context when Kittler as well poses an explicitly archaeological question: "Das wäre meine archäologische und diskursgeschichtliche Frage: woher kommt dieses wundersame System der modernen Mathematik mit ihren reelen Zahlen? <...> es ist singulär in der Geschichte der Menschheit, daß eine Kultur berhaupt versucht hat, mit reellen Zahlen die Welt zu berechnen und zu beherrschen."[391]

A "pixel" is the smallest conceivable digital picture element, which makes phenomenal sense in an iconic way only when appearing within a group. The "digital" means the countable; media archaeology is a radically mathematical mode.

When humans calculate in their mind and are equipped with paper, eraserhead and pencil, Alan Turing writes in his seminal paper of 1936 "On Computable Numbers", they are in a non-human, rather machinic mathematical state. This asks for analysis in terms of *mediamatics*.

CONFRONTING ARTEFACTUAL TEMPOR(E)ALITIES: RADICAL MEDIA ARCHAEOLOGY

Archaeologizing the present: Digital compression and micro-processor ageing

With digital communication culture, what used to be the technological present for generations, like radio and television as independent media systems, rapidly recedes into a past that feels antique or even historically distant. This discontinuation of the "analogue" does not happen naturally, but happens in two forms of techno-logical *archaeologization* of the present.

The core operation of translating signals from the anlogue world for computational use is digital sampling. Even if, according to the Sampling Theorem in communication theory, nothing is lost when the "continuous" signal becomes quantized into sequences of bits, audiovisual "big data" need to be compressed for storage and transmission. This leads to a different kind of signal "discard" and "residual media"[392]. To focus attention of this digital sacrifice, research artist Ryan Maguirre applied a kind of acoustic "garbage

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390 Martin Kusch, Discursive formations and possible worlds. A reconstruction of Foucault's archeology, in: Science Studies 1/1989, 17-25 (17)
391 Friedrich A. Kittler, Die Maschinen und die Schuld, interview by Gerburg Treusch-Dieter in: Freitag No. 52/1, December 24, 1993
392 See Charles Acland (ed.), Residual Media (University of Minnesota Press) 2007. See further Caleb Kelly, Cracked Media: the sound of malfunction; MIT Press 2009, on artistic abuses and extensions of media technology

archaology" (Ratje) by re-collecting the sonic rubbish[393] left by the compression of "musical" data.[394]

The MP3 codec implements a lossy compression algorithm based on a perceptual model of human hearing which determined which sounds were perceptually non-important and could therefore be erased.

What does such rejected data sound like? Patrick Maguirre has developed techniques to recover such lost sounds.

The material left behind by MP3 data compression is worth listening itself. "White, pink, and brown noise, when compressed to the lowest possible MP3 bit rate, sounds very different from the original random signal" (Patrick Maguirre).[395]

Maguirre has produced an audio "[...] comprised of lost mp3 compression material from the song *Tom's Diner* which had been used as one of the controls in listening tests to develop the MP3 encoding algorithm:

"Here we find the form of the song intact, but the details are just remnants of the original. The video is the MP4 ghost of a corresponding video [...]. Thus, both audio and video are the 'ghosts' of their respective compression codecs."[396]

While audio-visual attention to "the ghost" of MP3 files appears somewhat metaphysical, the laws of media applied here are rooted in techno-mathematical precision.[397] Probably the phantasm of "haunted media" (Geoffrey Sconce) applies to analog, that is: signal-based media recordings only, not to digital data processing any more.[398]

Next there is a second form of *archaeologizing* the present.
Not only for obsolete analog electronic hardware but for digital media as well, there is a premature, actively enforced ageing for economic or other stratetic reasons: the planned "insuetude" of micro-processors by *online* attacks. Software for aggressive fast ageing of microchips such as MAGIC (Malicious Ageing in Circuits, experimentally developed at New York University) causes negative-bias temperature instability.[399]

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393 On the re-cycling of cultural value, see Michael Thompson, Rubbish Theory, xxx
394 The Ghost in the MP3, http://theghostinthemp3.com/theghostinthemp3.html
395 See the video: Ryan Patrick Maguirre, moDernisT, created by salvaging the sounds and images lost to compression via the MP3 and MP4 codecs, from: http://theghostinthemp3.com; accessed January 4th, 2016
396 http://theghostinthemp3.com; accessed 4 Jan. 2016
397 See Jonathan Sterne (2012); MP3: The Meaning of A Format; Duke University Press
398 A thesis expressed by media historian John Durham Peters; see xxx
399 Announced in: ACM Transactions on Architecture and Code Optimization. For a comment in German on such computational *Progerie* see

All of the sudden, while entropy is the Shannon measure of "binary information units" itself, one is reminded of the physical entropy of computation: Symbolical machines are always *incorporated* in real matter. There is physical decay of media artifacts. This refers to entropy in the sense of the second law of thermodynamics, assuring the irreversibility of the physical time arrow. But in an epistemologically dramatic turn, entropy has become a measure in information theory where neither matter nor energy counts (Wiener). Instead of "material literacy", there is informational code knowledge. The current nostalgia and concern for the physical (discharge) and energetic (ecology) aspects of technologies are phenomena of a "post-digital" aesthetics, by-passing the challenge of techno-mathematical theory of communication and "Shannon entropy". Re-socializing, "re-worlding" and re-anthropologizing technology as an act of reconciliation of existential human experience of being in the physical world with the technological challenge follows the wrong track of the archaeological question: a dead end, as opposed to "radical" media-√ology.]

Media-archaeological analysis reveals what goes on in the ground of computing, that is: with*in* microchips.[400] Media archaeology therefore is less about beginnings and "old" media, but about their *processual* contemporalities - "virtual temporality"[401] in the precise sense of calculated realities.

In between materiality and logical diagram: Paper machines

"Paper Machine" is the name given to a publication of Jacques Derrida on the current state of computer-based writing.[402] Derrida remarkably misses the point that "paper machine" is an expression in Alan Turing's seminal paper on discrete computing itself (1936), while treating this machine rather like black box which remains an enigma for philosophers. Maybe philosphers might become computer-literate in the media-archaeologically sense which reveals its techno-logical *alethéia*.

There are not only methodological and philosophical overlappings between the two disciplines of cultural and media archaeology indeed, but significant gaps between those two practices. The archaeological focus on materiality may be

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http://www.zeit.de/digital/internet/2015-10/geplante-obsoleszenz-magic-software-laesst-hardware-altern (22. October 2015)

400For a reverse perspective, see Christine A. Finn, Artifacts. An Archaeologist's Year in Silicon Valley, xxx 2000

401A term coined by Ignacio Infante, After Translation. The Transfer and Circulation of Modern Poetics across the Atlantic, New York (Fordham University Press) 2013, 170: "[...] any point in time can be retraced and accessed instantaneouly". Matthew G. Kirschenbaum, Track Changes. A Literary History of Word Processing, Cambridge, Mass. / London (The Belknap Press of Harvard University Press) 2016, 320, note 61, comments on this archival capability: "Not incidentally [...] Apple's current backup sytem for its computers is named Time Machine."

402 Jacques Derrida, Paper Machine, transl. Rachel Bowlby, Stanford, CA (Stanford University Press) 1995

adequate for traditional cultural artefacts but is not for techno-mathematical devices.

Media archaeologists favor objects which oscillate between symbolic code and material embodiment like punch cards. Such punches in an antique computer card are not absent matter but information. The punch card indeed is an object inbetween cultural materiality and mathematical logic.

"Post-digital" nostalgia for archaeological materiality?

Recently the so-called "post-digital" has emerged as a new term in media-cultural and media-artistic discourse, indicating a nostalgia for the haptic, the material and the tangible which has disappeared in algorithmic computing. But the second component of the term "technology" rather refers to the *logos*, the mathematical, logical, algorithmic aspect of contemporary culture. Media archaeo*logy* refers to the sublime mechanisms and temporalities of data processing, and is "radical" rather in the sense of the mathematical symbol for numerical root ratios than as search for temporal origins.

"Radical" (square root) media archaeology is less about the application of algorithms that build up classification or seriation of material artifacts in archaeological research (Flinders Petrie) but rather a techno-mathematical anlysis, of such algorithms themselves, an un-revealing of their operational diagram and their electro-physical embeddedness in "hardware".

B. Jaulin, though, has articulated an early critique of such "anarchaeological" methods in archaeological analysis, "namely the use of algorithms that build up classifications of artifacts on the basis of their description. The lack of justification in the anarchic use of such procedures is manifest at different stages. Our main purpose is the study of hypothesis related to the measure of differences in the `similarities´ between objects."[403]

What kind of *archéologie*?

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*

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403 B. Jaulin, Mesure de la Ressemblance en Anarchéologie, in: J.-C. Gardin (ed.), Archéologie et Calculateurs, Paris (CNRS) 1970, 343- (343)

of Knowledge (1969/1972). Foucault is not to blaim for reducing the term "archaeology" to a metaphor; Foucault has rather been frequently misinterpreted by archaeologists and cultural historians. Foucault on several occasions distanced himself from a literal interpretation of *archèologie* as digging metaphor or as reference to geological layers; he rather reactivated the need for a "philosophical archaeology" (as once expressed by Immanuel Kant) which means an inquiry into conditions of possibility for cognition (the *a priori*). 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" (AK). 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 we call *online* access to the Internet of communication and things.

Toward a re-definition of the "material artefact": the focus on Object-oriented programming, on operativity rather than matter

In electrified digital times, cultural traces (texts or objects) are not simply material any longer; the notion of the artefact itself rather needs to be re-defined. Errors in digital image processing are called "artefacts", with their sonic equivalent being "glitches". The artefact is both physical and logical. Media-archaeological criticism therefore refers to techno*logics* which is algorithms implemented in physical matter, the marriage of matter and mathematics. Media-archaeological observation focuses on the spatial and time-critical moments of contact (even the quantum energetical interference) between physical matter and logical coding.

Since the development of the computing language SIMULA in Norway, the notion of the material object has changed. Object-oriented programming does not write lists of code lines any more which sequentially operate routines and sub-routines but rather manipulates objects which simulate the real world as instanciations of classes. While a class or type in Object-oriented programming rather looks like a Platonic idea[404], instances are particular algorithmic individuals. "*Instances exist in time and space.*"[405] Object-oriented programming resulted in the computational neo-logism of an "abstract materiality"[406].

Media- archaeological practice can not be reduced to materiality but deals with mathematized meta-realities. Computers and algorithms themselves here

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404 See Casey Alt, xxx, in: Huhtamo / Parikka (eds.) xxx
405 James M. Fielding / Dirk Marwede, The Anatomy of the Image: Towards an Applied Onto-Psychiatry, demnächst in: Philosophy Psychiatry and Psychology, xxx
406 Matthew Fuller / Andrew Goffey, Die obskuren Objekte der Objektorientierung, in: Zeitschrift für Medienwissenschaft 6, Heft 1/2012, 206-221 (221)

become active agencies of media archaeology, such as in Patrick Feaster's literally audio-visual computational retrieval of pre-Edison "first sound" recordings with image-to-sound software, and the "restauration" of the first electro-mechanical television recordings (John Logie Baird's *phonovision*) by Donald McLean.

Media archaeology reveals the material and logical, therefore: techno-logical principles (ancient Greek *archai*) that drive signal transduction and data processing in the architectural hardware and archival textural software of computing. This necessarily includes analysis of its operativity, that is: truly processual media-archaeology, revealing temporal and time-critical patterns of the medium - just like contemporary archaeology as such nowadays shifts the focus of analysis from the distant past to the "production of presence" (Gumbrecht).

Past media can be "re-presenced"[407] not by shere materiality; they rather require operative re-enactment, operative presence (which is the ratio for assembling techno-epistemological "toys" in the Media Archaeological Fundus and the Signal Laboratory at Humboldt University).

Anatomy of Kittler's modular sound synthesizer

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 which have been familiar to humanities be applied to elctro-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. This is hardware-oriented media hermeneutics in the tradition of what the archaeologist Eduard Gerhard in 19th century once called *monumental philology*.

Rethinking computing with Heidegger

As has been identified by Vivian Sobchack, the archetypal *emplotment* of media archaeology is not simply an antiquarian love for the ancient artefact, but as well the romantic desire to revive it "through a transhistorical *operative practice*"[408] which correlates with Martin Heidegger's reading of ancient Greek

407 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

408Sobchack, Afterword, in: Huhtamo / Parikka (eds.), xxx, 324

techné: "a 'revealing' that not only 'brings forth' but also *makes present*"[409]. In the philosopher's own words: "No matter how sharply we just *look* at the 'outward appearance' of Things in whatever form this takes, we cannot discover anything ready-to-hand. If we look at Things just 'theoretically', we can get along without understanding readiness-to-hand. But when we deal with them by using them and manipulating them, this activity is not a blind one; it has its own kind of sight, by which our manipulation is guided and from which it acquires its spefific Thingly character."[410]

Technology is not primarily a way of making or doing things, but rather itself an archeological action: "a way of revealing things that precedes the making"[411]. The essence of *Technik* is by no means simply techological; it is rather *Gestell*: a framework, like a mill. "Mill" accidentally was the term Charles Babbage used to described the central processing unit of his nineteenth-century full-mechanical proto-computer, his Analytical Engine).

Mathematical thinking precedes both the materiality and the coding of computing technologies. Thereby it once led to mathematizing material machines like Babbage's Engines and later to mechanizing mathematics itself: Turing's 1936 conceptual computer.

Arché and *logos*

The very term archeology itself is indicative: *arché* and *lógos*. An *arché* is never simply a beginning; it is a massive rupture, a leap forth, "implicitly anticipating whaterver springs from it [...]"[412].

A lot of recently familiar technological such as analog radio devices abruptly getting out of use with the "digital" present; a new "antiquity" emerges as pre-history or even: pre-historical archaeology of the "contemporary now" (the Benjaminean *Jetztvergangenheit*).

Still, antique electronic circuit diagrams remain readable, in equiprimordial, even ahistorical invariance towards temporal change - just like a geometric drawing on an ancient Egyptian papyrus can still be deciphered as a mathematical argument.

[The Heideggerian term "gleichursprünglich" (equiprimordial) signifies that two constellations are neither derivable from or based on the other.[413]]

Arché shall not be reduced to the study of beginnings; it as well expresses the lasting impact, the ongoing rules and order resulting from that origin. In Aristotle's scientific philosophy, "*arché* means, at one and the same time,

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409Quoted ibid.
410 Martin Heidegger, Being and Time, New York (Harper and Row) 1962, 98
411 See Inwood, Heidegger Dictionary (1999), 209
412 Inwood, Heidegger Dictionary, 152
413 Inwood, Heidegger Dictionary, 152

beginning and control <...> origin and ordering."[414] Heidegger emphasizes "the unity that oscillates between the two", in a kind of historic-archaeological double-bind: thinking structure and time. The archaeological act of revealing (*aletheia*) precedes *logos*; the very term "archeo/logy" is disrupted by that epistemic gap.

The affinity between media archaeology and pre-historical archaeology

It is by epistemologic necessity that there is a close affinity between radical media archaeology and *pre*-historical archaeology as such. It is mainly prehistorians which recently turned to an archaeology of the present or even future challenges such as nuclear waste site preservation.[415] "Knowledge of a pre-history [Ur-geschichte] is not unearthing the primitive"[416], but rather an archaeology of the present techno-logical condition.

Media archaeology operates with a different tempor(e)alty of material things. Still, there is a clash between the anthropocentrism of academic archaeology (focusing human performance) and *media* archaeological notions of non-human agency (operativity) and technological *eigenzeit*. Here, the real protagonists are rather the machines than the people who created them.[417] Inventors should be mentioned, but their creations are controlled by some rather external machinic logic. Media can be studied without people"[418] - in *radical* versus *historical* media archaeology.

The alliance of "processual" archaeologies

In affinity to so-called processual archaeology, inbetween hermeneutics and cultural semiotics, media archaeology as well is less concerned with the human behind the artefact, but rather with the system embracing both[419], oscillating

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414 Martin Heidegger, On the Essence and cncept of *Physis* in Arostotle's *Physics* B, I. In: M. H., Pathmarks, Cambridge (Cambridge UP) 1998, 189

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

416 Heidegger, IM, 119/131; quoted here after Inwood xxx

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

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

419 Kent V. Flannery, Culture, History vs. Cultural process: A Debate in American Archaeology, in: Mark P. Leone (ed.), Contemporary Archaeology. A Guide to Theory and Contributions, Carbondale 1972, 105. See Ian Hodder / Scott Hutson, Reading the Past. Current Approaches to Interpretation in Archaeology, Cambridge, 3rd ed. 2003; furthermore Robert W. Preucel (Hg.), Processual and Postprocessual Archaeologies. Multiple Ways of Knowing the Past, Carbondale 1991

between agency and structure in "post"-structural analysis. As soon as the operative context of an artefact is known, it is no longer silent.[420]

Is it mandatory to defend the "monumental" approach *versus* making it speak as "document"? Technologies do not "speak", though, but they act.

The very term technology can be deciphered in this sense. *Lógos* and *techné*, words and material things, "are not documents to be read, but `monuments ´"[421] - mapped on the technological mediascape. It is for this reason that Foucault did not label his inquiry "historical" but "archaeological".

Radical media archaeology instead of "dead media" research

To traditional archaeologists and historians, the emergent research field of media archaeology looks like being devoted to the curious or forgotten paths in the history of technology. Siegfried Zielinski's approach takes care of such a "variantology" indeed.[422] Radical media archaeology, on the contrary, avoids the attractive and seductive, but tranquillizing metaphor of resurrecting "dead media".

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[423], the resulting project ("part archive, part nostalgia, part requiem"[424]) itself almost disappeared and "became obsolete" (ibid.). The thematic mailing list itself died. Even if the Dead Media Project still holds a URL[425] and has a 'holding' Web site in place with (a) few functional links, "[t]ragically, all the links capturing the research and comments [...] are disabled or broken. Instead, media artist Garnet Hertz revived such projects in his research.[426] The cultural phantasm of the "undead" needs to be re-defined in technical terms.

"E. T." as topic of computer (game) archaeology

Media archaeology is not an abstract theory but primarily an applied research method; its character is both object-oriented and operational, esp. when the

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420 Hodder / Hutson 2003, 5

421 xxx, in: History and Theory XX (3/1981, 253, unter Bezug auf: The Archaeology of Knowledge, transl. by A. M. Sheridan Smith, N. Y. 1976, 7, 106-117, 138-139

422 Siegfried Zielinski / xxx (eds.), Variantology, xxx

423 Bruce Sterling, The life and death of media, speech at Sixth International Symposium on Electronic Art ISEA '95, Montreal, (19 September)

424 Tara Brabazon, Dead media: Obsolescence and redundancy in media history, in: First Monday, Volume 18, Number 7 (July 2013), at http://firstmonday.org/ojs/index.php/fm/article/view/4466/3701 doi:10.5210/fm.v18i7.4466; accessed November 20, 2015

425 http://www.deadmedia.org

426 See Garnet Hertz, A collection of many problems, Los Angeles (Telharmonium Press) 2009, at http://www.conceptlab.com/problems

focus is on computing. While the Turing Machine has been an operative diagram for computing numbers on paper, computers as we know them nowadays actually take place in physical hardware and individualized computer architectures.[427]

What separates computers from previous technologies is its double-bind of being *both* material hardware and symbolic software. "Obsolescence" in computing can not be reduced to the naive understanding of digging out its residual materialities.

An archaeology of digital culture can never be reduced to the material, "stones and bones" artefactual interpretation; it has to confront that its technologies come into media-being only processually. Media hardware, like skeletons or architectural walls, tends to remain; but its flesh is software which, like electrons themselves, is volatile.

The archaeological metaphor for digital media has been triggered by the spectacular digging out of *E. T. - The Extraterrestrial* computer game cartridges a few years ago. The commercial failure of the computer game *E. T.* (designed for Atari in 1982) once led to its literal "dumping" in the sand of New Mexico in 1983 - until its spectacular archaeological rediscovery in 2013.

[But the real media-archaeological issue is "core dump", like the Hex-Dump representation of storage content.]

This computer game has since become subject of a soft and a hard way of practicing media archaeology. Ironically, the soft archaeological version concerns hardware, and the hard media archaeological version concerns software.

Different from materialist archaeology, media archaeology of computer games involves the symbol manipulation level of source code as well. Precisely this requires *disassembling* a given Atari game module microchip, which leads to a new meaning of the very term archaeo-logy: revealing the computer *logos*, different from simply opening the electronic circuitry in analog media.

Only disassembling brings into symbolically readable form what is physically buried as memory in a computer game.[428] Binary data stored in physical memory cells, once being detected, can be re-translated into the symbolical mnemonics of Assembly language. The special operation of disassembling means that the raw machine language of the program is read and understood in its own terms. But other parts of the coding process still requires hermeneutic interpretation in the effort of making sense of an obsolete programming text again - such as the commentaries in Assembly code written by humans, which are not being stored in machine language.

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427 An argument by Stefan Höltgen in his presentation "It's more fun to compute!" Theoretische und operative Begriffsbestimmung von "Computerarchäologie", July 9th, 2014, at the research colloquy *Medien, die wir meinen*, Humboldt University Berlin, Media Studies

428 Höltgen 2015: 130, note 18

The experimental reproduction of past technologies can offer archaeological insights into present configurations as "layers" indeed. A genuine "archaeology" of past computing practice is its re-enactment by emulators.

While electro-physical intusion in opening actual hardware might destroy this symbolic machine, mnemonics and hexadecimal values represent the op-codes of machine language and the binary values symbolically and thereby allow for non-invasive reading. Once the hardware of an archaic computer game like E.T. has been emulated, in real-time debugging its software can be analyzed and manipulated in single-step mode.

This is an alternative kind of archaeology: no digging in the desert for cartridges but within the source code (the binaries) of the cartridges themselves.[429] Thereby, media archaeology does not play with the computer game but with its code.[430]

Even if such retro-computing at first sight appears like nostalgia for "dead media", its epistemological value is critical media philology of new kinds of archival records from the past. Contrary to the romantic image of buried computer game modules in the desert, the non-material code of *E. T.* has been present all the time and has been "kept alive". Processual analysis of ancient game code layers by debugging leads to an operative definition of computer archaeology which does not reconstruct historical material but operates within a different temporal regime of equi-primordiality between past and present computing.

In a similar kind of experiment, the Aperture Labs managed to read out the raw bits preserved in electro-magnetic remanence on Read Only Memory chips.[431] These were put through a disassembler and become re-readable as code again.

The distinction between hard- and software for computer culture does not suffice, to be supplemented by an analysis of the operational machine behaviour (for which Babbage once developed his "symbolic notation").[432] This is a new form of *processual archaeology* for technological items. The monumental record (be it hardware of source code) must be set "in motion" in order to become a media-archival document at all.[433]

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429 See David Richardson, Fixing E.T. The Extra-Terrestrial for the Atari 2600: www.neocomputer.org/projects/et (2013)

430 Stefan Höltgen, *It's more fun to compute!* Retro-Games als Wissensobjekte, in: Ann-Marie Letourneur / Michael Mosel / Tim Raupach (eds.), Retro-Games und Retro-Gaming. Nostalgie als Phänomen einer performativen Ästhetik von Computer- und Videospielkulturen (Verl. Werner Hülsbusch) Glückstadt 2015, 49-66

431 See http://adamsblog.aperturelabs.com/2013/01/fun-with-masked-roms.html; accessed July 10, 2014

432 See as well Franz von Reuleaux, Theoretische Kinematik, xxx 1875

433 See Eivind Rossaak (ed.), *The Archive in Motion*, Oslo 2010

But there remains some kind of an uncertainty relation in such media archaeological observation of technical devices: One gets either as close as possible to their electro-phyiscal materiality, or close to their temporal dynamics which is algorithmic operativity. The undecidability of the literally techno-archaeo-logical question pertains: Where does symbolic op-code end, and where does material machine language start?[434]

Media-archaeological insight: the Janus-faced interface (Fry's *deconstructulator*)

Ben Fry's *Deconstructulator* - created as part of his "Visually Deconstructing Code" series shown in the Ars Electronica 2003 CODE Exhibition - "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."[435] Fry's *Deconstructulator* modified source code of the NESCafe emulator written by David de Niese which Fry hacked up literally "a bit" (bit-wise) "to dynamically show aspects of how the machine works" (ibid.).

Really "forensic" media archivology: Reading a ROM

What is discourse-analytically kept apart in the introduction of Foucault's *Archaeology of Knowledge* is dialectically synthesized in the digital computer: it encompasses both "document" (source code) and "monument" (its physical hardware architecture).

Hardware without code, and in reverse software without material embodiment, would be "the computer" in theory, but not real computers as operative media. This asks for different excavation practices.

How "material" is software? "[...] trying to do something like reset a fuse to allow reading/writing of protected areas or probe a data track to observe data being processed by the chip" is material criticism: materially de-constructing computer chips by reverse engineering it's construction. Such software hacking is dangerous on the level of the symbolical order of computing, while tinkering with circuits that are directly connected to mains is dangerous in an electric sense.

It is possible to get literal "insight" into the computer not only as a posthumous archaeological device which can be "excavated" by opening it physically, but while it runs. Whatever we see on a computer monitor is a direct function (and therefore indeed "indexical") of its data storage allocations. In times of the so-called Williams Tube the cathode ray tube did not primarily serve as a computer-to-human interface but as an intermediary RAM itself.

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434 See Semen Karsakov, Ideenmaschine [1832], Berlin (Kulturverlag Kadmos) 2xxx

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

One specific media-archaeological (or media-archival) target is the program code that is stored in a masked Read Only Memory (ROM) chip. As long as the chip itself is using a known architecture and assembly language, reverse engineering is able to recover the actual instructions stored in the ROM; "data" is clearly discernible.

A second-order observation paradox in media archaeology arises. Computer software - even if it is able to archivize all other previous forms of cultural memory - can not itself be displayed from within.[436]

Therefore museums of computer architecture are necessary to store hardware architectures and software solutions - "so precisely as to preserve at least the validity of mathematical algorithms" (Kittler ibid.). But this has to be done as executable programs instead of passive reading - which makes all the difference to the Gutenberg Galaxy, beyond the *stasis* of traditional textual archives.[437]

The term "interpretation" of source code is problematic already: Before a human reader can make sense of such a text, it must first be logically be "interpreted" by a compiler or "interpreter".

Media archaeology (like critical philology) always insists on the close examination of the material artefact instead of simply relying upon its edited publication. There are always features of the (analog) original which are not (digitally) reproducible.[438]

This changes when the physical laboratory in experimental science is replaced by computer simulation itself.

A digital file "is not a document in its own right - it merely describes a document that comes into existence when the file in interpreted by the program that produced it"[439]; digital image is not coherently framed any more in space like the cinematic shot but is being regenerated dynamically in time. Archaeology becomes chronopoetic; the equivalent to the archaeologically hidden object is the techno-real moment of the *temporal* gap.[440]

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436 An argument made by Kittler 1996: 78
437 See Doron Swade, Collecting Software: Preserving Information in an Object-Centred Culture, in: History and Computing, vol. 4, no. 3 (1992), 206-210; furthermore: same author, Virtual Objects – Threat or Salvation?, in: S. Lindquist / M. Hedin / U. Larsson (ed.), Museums of Modern Science, Canton, Mass. (Science History Publications) 2000, 139-147
438 See Dymond 1974: 55
439Rothenberg 1995: 44
440 See Stefan Höltgen, JUMPs durch exotische Zonen. Portale, Hyperräume und Teleportation in Computern und Computerspielen, in: Thomas Hensel / Britta Neitzel / Rolf F. Nohr (eds.), "This cake is a lie!" Polyperspektivische Betrachtungen des Computerspiels am Beispiel von "Portal", Münster et al. (LIT Verl.) 2015, 107-134

MEDIA ARCHAEOLOGY AS METHOD OF RESEARCH IN PARALLEL LINES (MEDIA ART, ACADEMIC MEDIA THEORY)

In/compatible? Media Art and academic research

Can verbal language aptly describe the electronic circuitry and the algorithms which are active within media art? Media artists have a "radar system" (McLuhan) for the detection of new trends in techno-aesthetics themselves, rather parallel than directly dependent on academic discourse. Both develop in independent ways.

Media theories rarely have a direct impact on artistic production - except a few cases like Marshall McLuhan, Vilém Flusser and Friedrich Kittler. New methods are rather *induced* by the very denominator which is shared by media art as well as by media theory: media themselves.

Research as method

All over the *transmediale.12* festival in Berlin it could be noticed that a conceptual awareness of material frictions and informational disruptions within the so-called digital culture is vibrantly present, dis-covering what has been already there, but more or less hidden or subliminal. Different from the utopean visions which have dominated the first generation of media art, precise re/search corresponds with the literal meaning of the Latin term *inventio*: that every invention is as well a re-invention (in German: *Wied/Erfindung*), undiscovering the "always-already-there".

Berlin-based media artist Jan-Peter Sonntag has directed (in the Baroque tradition of the *theatrum anatomicum*) 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.

Christian Schliebs has installed of a viable three-dimensional *camera obscura* in a gallery room (Sur la Montagne, Torstrasse) at Berlin, called *SlaMera Obscura* (July 9/10, 2011). If Schliebs' knowledge and epistemological awareness (such as Platon's cave metaphor) of the camera obscura may have been a direct result of his university courses in Media Studies, the actual art installation led to insights which are not primarily based on academic speech and the printed text but on the physical experience - true "media theatre". The artistic installation explicitly served as a critical question addressed at the generation of Youtube-based *digital natives*[441]. The project report by Schliebs, though, takes the classical form of the textual argument. Academic media theory brings out the epistemological surplus which is dormant within media technologies; knowledge needs to become explicit in order to become reflective, and this primarily takes place in the medium of verbal text - the classical cultural

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441 Project report *SlaMera Obscura. Ein begehbares Lochkamerakino* (January 6, 2012) by Christian Schliebs, referrring to a notion coined by Marc Prensky

technology as practiced in universities. Different from that logocentristic explication of knowledge, there is *implicit* knowledge[442] which stays in a kind of latency (very archaeological) 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.

The commercial industry for human-machine interfaces tends to erase the human/machine difference by creating the illusion of an immediate "dialogue"; the alternative ratio is to learn from the differences. New "methods" are not restriced to academic or artistic research, but is performed by recursive machines themselves. An example is the Mandelbrot fractals which all of the sudden showed on the computer screen the *Gestalt* iterations which could never have been discovered by endless lines of calculation in symbols on paper by human mathematicians. In case of sound, sonographic software is able to analyze acoustic articulation in ways which symbolic music notation (the score) never could do. Another case: The *Detectors* as developed by Shintaro Miyazaki and Martin Howse sonify the hidden electromagnetic rhythms which surround us in everyday electronic devices, thus revealing the algo-rhythmical, even musical character of inernal micro-processor activity.

A new kind of media historiography?

Media archaeology does not narrate, because machines do not tell stories, they count. Algorithmics precedes narration.[443] In fact, Jean-Luc Godard chose to change his medium from writing to video editing when creating his *Histoire(s) du Cinema* as an artistic attempt of media archaeography in a non-textual way. And Michel Foucault's *Archaeology of knowledge* has not just been another method in how to conceive the history of culture and technology, but more challenging, it still is a vibrant chronopoetics, an alternative to the discourse of history itself. Media historiography and media archaeology, to a certain extent, are in/compatible in the most productive way; they are fundamentally different approaches to the temporal layers of technological media and their human condition.

Manuel DeLanda imagines a future "robot historian" to write the retrospective archaeology of current media culture; it is essential to media archaeology as method to take (or simulate) the techno-mathematical point of view of the media themselves. Media archaeology as academic method is performed by humans; but there are cases where the media themselves all of the sudden actively become the archeologists of past signals and data, be it numerical, texts, acoustic or optical.

When Samuel Beckett's one-act drama *Krapp's Last Tape* was performed in 1959 on the theatre stage, the main protagonist was a magnetic tape machine re-playing the human actor's voice from years ago - veritable "media theatre".

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442 See `Michael Polanyi, Personal Knowledge, Chicago (The University of Chicago Press) 1958`
443 Lev Manovich, in: The Language of New Media, notably differentiates databanks from narrative.

That leads to non-metaphorical acoustic research, an archaeology of the voice as performed by the technical medium of recording and re-play itself.

While conventional media historiography as symbolic organization of cultural time tends to priviledge linear stories of the type "from abacus to computer", let us instead diagrammatically imagine 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.

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. A 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).

The media-artistic impulse is not just a passive product of the current media sphere (or "media ecology", as expressed by Marshall McLuhan), but actively assists in dis-continuing former practices which hinder us 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 itw own, not exclusively subjected to the contextual time of discourse in which they are embedded. Video artists like Nam June Paik have articulated media temporality and materiality, transcending simply time-based performances (like theatre) towards an archaeology of time-critical processes, i. e. media practices where micro-temporal action is decisive for the success of the event at all.

Both in artistic and academic media archaeology the temporal dimensions and recursions of technologies has been a growing subject. The time axis manipulation in the media installation *The Insivible Shapes of Things Past* (1995-2007) by Joachim Sauter / Dirk Lüsebrink (Art + Com, Berlin) spatializes the time-based sequence of cinematic frames into sculptures of movement, making *The Shape of Time* (George Kubler) actually tangible.

Media archaeology as method a) in academic research, b) in artistic practice and c) as active media operations

Media archaeology is not simply a metaphor for digging out material knowledge of technologies past, and it can not be reduced to unearthing "dead media" as once described by Bruce Sterling - although this in fact 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[444] 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

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444 Edition Two, Telharmonium Press, California, 2010

operative coupling with the "field" it needs to be literally embedded in. A stripe of punched Morse code (which I found inserted in a previous edition of this *Collection*) might now actually be re-inserted into a reading mechanism which can decipher the latent message. The piece of wire most probably magnetically stores a voice or piece of music recorded decades ago; when inserted into a working Wire Recorder (re-activated, maybe, from a technical museum), one might all of the sudden perceive voices from bodies which probably have passed away already. This experience is not about dead media, but about media as being undead - a latency wainting to be processually activated. There is an untimeliness of media which is incorporated here.

When simply exhibited in a museum, an old Edison phonograph is dead matter indeed, a cultural artefact but not a medium. Once an Edison cylinder is played on it, Enrico Caruso's voice might be heard, however noisy. Only when in operation a technical device is really in its medium state, a "medium in being" (parallel to the British navy expression of ships in military operation, a "fleet in being"[445]), 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 Paik's days makes us phenomenologically experience radical presence - which is the affective power of such media.

On 1st of February, 2012, German Deutschlandfunk radio announced that the voice of the German chancellor Otto von Bismarck has been re-discovered - from and as medium. In fact, different from the early morning newspaper report on this discovery, the medium radio could actually perform what it talks about and re-play the Bismarck voice file.[446] The radio commentator remarked on the signal-to-noise ratio of this record: "Das Lauschen und Rattern der Tonwalze ist lauter als das, was der Reichskanzler sagt." The material glitch here is the message - signalling the media tempor(e)ality of non-historical voice memory.

The *a posteriori* of media art?

For sure, technological media are in the most direct way products of human culture. But as already noticed by McLuhan (referring to Samuel Butlers science fiction novel *Erewhon*), machines have emancipated in the meantime. Man lags behind; implicit media knowledge is ahead of a current user practice. That is why the "content" of a new medium is always simply the previous one. As indicated by Günther Anders in his book on *Die Antiquiertheit des Menschen* which carries the archaeological moment in its title: Humans are belated when compared with the possibilities dormant within technological products (the inverse media archaeological potential). Is art, since the age of technological reproduction, lagging behind, when media themselves become the agency of artistic production so that the artist is just the "shepard" of his technological objects (*Objekthirte*, as expressed by Anders), such as Carsten Nicolai's

445 A reminder I owe to Bernhard Siegert; see his contribution to: TRANSIT Innsbruck (Hrsg.), On the Air. Kunst im öffentlichen Raum, Redaktion: Heidi Grundmann / Nicila Mayr, Vienna 1993

446 Combining the printed report with the option of listening to the voice (by activating the sound file) is the Internet platform. See *Spiegel online*: "Tonaufnahmen vom Reichskanzler", http://einestages.spiegel.de/static/topicalbumbackground/24306/so_klang_bismarck.html

sonifications of electricity under "oscilloscope"? "Sonic" delay lines were developed for short-time storage in early digital computers (Turing's ACE) first, before this hybrid technology was re-discovered in Yun-Chul Kim's media art installation *Hello World!* (once presented at Ars Electronica in 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 art as anamnesis of these layers.[447]

In/compatible media tempor(e)alities

Media archaeology - in agreement with Siegfried Zielinski - on the one hand is providing a deep temporal dimension to current media practices. But this deep temporal dimension is not necessarily of a historical kind - which is the meaning of artistic critique of the concept of media history.

The *arché* in media "archaeology" is not primarily about origins in the past, but about discovering principles, the rules that govern media operativity both as hard- and as software, as commandment (in the Derridean sense[448]). Archaeology as the "beginning" of the techno-condition is an active command, execution in the software sense, of orders, procedures, patterns and routines. Thus media archaeology is the analytic reduction of complex techno-mathematics to the essentials, such as the return to Assembly programming language which is time-critically close to the machine. Here, mathematical operations become material.

Gregory Barsamian's media art installation *The Scream* (1988), presented in the exhibition *Vom Funken zum Pixel* [449], has been inspired by early animation techniques previous to the intention of cinematography proper (such as the Zoetrope or the Phenakistoskope) and at the same time in its material installation is a reminder of the difference to pixel-based moving images. Another example is the long-time ("Bergsonean") photographic exposure of theatre performances by Aljoscha Begrich, Lucas Fester and Jo Preußler, exhibited under the title of *Flüchtige Totale* in the Deutsches Theater, Berlin, April 2005.

"Precedents for our own digital concerns might be found in technologies as recent as 30 or 100 years ago."[450] Media archaeology is not necessarily about contextual information about past media, but creating such situations where

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

448 See Jacques Derrida, Mal d'Archive, Paris 1995

449 October 2007 til January 2008, Martin-Gropius-Bau Berlin, curated by Richard Catelli

450 The announcement of Rabinovitz' faculty research seminar *The Usable Past: Historical Perspectives on Digital Culture* (summer term 2000 at The University of Iowa, Obermann Center for Advanced Studies

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."[451] 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 we mistake as human.

"Media archaeology is processual, it focuses on the time-critical processes which engineer our lives" (Parikka ibid.); media archaeological arts are actually less about artists working with historical material than about hardware hacking, open software and circuit bending. Media archaeology is not simply about hardware but also about microtemporal processes, as practiced in the *Microresearch lab*, Berlin.

Media archaeology can not be relegated to the sciences faculties but is keep within humanities, because this method is most of all interested in the epistemological conditions in which the commands, executions and operations take place. This points towards the micro-political contexts of media archaeology which is hidden in the physical and logical layers of media machines and need to be articulated radically. Academic media archaeology then has a special responsibility to open up systems (black boxes). In that sense, media archaeology has some connection with platform and software studies[452], revealing the double-nature of such studies between the cultural interface and the computational heart, the beat of which is essentially "algorhythmic"[453]. Machines are agents of cultural time. They record, process, transmit "and do not always ask for permission from the human being" (Parikka). Media-archaeological research is performed by artists, academics, and foremost: by machines themselves.

RADICAL MEDIA ARCHAEOLOGY (its epistemology, aesthetics and case studies)

Media Archaeology is both a method and an aesthetics of approaching technical objects. With reference to Foucault's *archéologie*[454] and with its emphasis on the nonhuman, media-active archaeology, radical media archaeology differs from the soft archaeological metaphor. One characteristic of Media Archaeology is its focus on technological materialism, analytically or creatively bound to practices like circuit bending, while a more rigorous

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451 Jussi Parikka, Cartographies of Media Archaeology, entry November 22, 2009 ("Professor Ernst's take on media archaeology"), http://mediacartographies.blogspot.com
452 See Ian Bogost / Nick Montfort, Platform Studies. Frequently Questioned Answers, in the *online* journal: Digital Arts and Culture, December 12-16, 2009
453 See Shintaro Miyazaki, xxx
454 See Michel Foucault, The Archaeology of Knowledge, transl. by A. M. Sheridan Smith, N. Y. 1976, 7, 106-117, 138-139

challenge is the techno-mathematical investigation of code and algorithms as the essence of computing. Computing is rooted in technical hardware, signal processing by electric fluidity and swichting gates, that 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*). Not simply a structural law, advanced technologies is dynamic, which makes all the difference between an algorithm as a symbolical mathematical notation (traditional archival record) and its implementation as running program. In computational devices, there is not simply a duality between the user interface and its deep hidden ground, but rather a Moebius-loop-like dynamical interrelation resulting from the very definition of its von-Neumann-architecture and corresponding human-machine interactivity.

To counterbalance speculative events like the excavation of once buried computer game cartridges (case *E. T.*), a more code-oriented, critical resistance to the archaeological metaphor becomes obligatory. The topic of video games, for a moment, induces a short media-archaeological *intermezzo* on film. Film as topic in media archaeology[455] depends on the understanding of its technocal message different from its iconic content. Media archaeology is fascinated with cinematography in terms of its mechanism, which is its chrono-photographic essence (returning within cinema as the genre of "Photofilm"). *Radical* media-archaeology even ignores the iconic feature of the photographic still, since the cinematographic apparatus can "process" all kinds of inscriptions on tape with step-wise intermittance. Its appeal is not primarily "cinema" as movie theatre event or as art form, but the epistemic momentum which arises from close technical and philosophical analysis of what happens *within* the cinematographic apparatus itself: its automatism and *automathesis*. (implicit knowledge). A radical media archaeological re-interpreation of cinematography is its time-discrete essence as implicit anticipation of the digital image. Chrono-photography and the "moving" photographic image have stilled time and return within the Turing machine, where its operational tape for reading and writing characters is the digital equivalent of the "moving still". The photographic step-wise film frame recording has already prefigured what is contemporary "sampling" of analog signals into digital data, while the framed image itself, in current computing, not only implodes into the pixels of the digital image like micro-frames, but even disappears into algorithmic moving image compression. Digital film, therefore, is both the apothesis and the *posthistoire* of the cinematograpic mechanism.

When bracketed by mechanically discrete cinematography and the computationally discrete digital image, inbetween there has been the epoque of the "analog" electronic image. Recently, algorithms themselves have become the media-active archaeologists of archaic video recordings, and for the challenge of media cultural heritage, digital video art preservation becomes a case study in applied media archaeology.

A term like "historical media archaeology" (occasionally used by Friedrich Kittler), in terms of Radical Media Archaeology, is an oxymoron. History and media archaeology are incommensurable. The media-archaeological method is

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455 Thomas Elsaesser, Film History as Media Archaeology: Tracking Digital Cinema, Amsterdam (Amsterdam University Press) 2016

rather about "re-presencing"[456] than historicizing "past" media technologies. Media Archaeology as method of logo-technical research stays close to the signal (be it analog waveforms or digital pulses).

Research such as the "Dead Media" project, in spite of its merits in reminding contemporary technologies of its past alternatives, requires a media-epistemological counter-reading. Diagrammatic media archaeography experiments with alternatives to culturally familiar narratives of media historiography. Therefore Media Archaeography as mode of its description is proposed. Technical "miniatures" are the core modules of media-archaeographical writing, a way of close reading or thick description of technical details as new kind of "historical" source. Nick Montfort's webseite Trope Tank, since 2012, assembles such a „Series of Technical Reports“.

Radical Media Archaeology against the soft archaeological metaphor

For media archaeological analysis, the notion of archaeological or even geological "layers" (stratigraphy) is metaphorical and misleading; with integrated circuits and logical arrays, and with the miniaturization of electronics into flat "smart devices" like the iPhone in general, prevails two-dimensionality (and its material extensions), both in terms of electronics and of the interface (the screen). The layer-wise erasure of micro-chips from Western production by East German computing industry in the 1980s and 1990s has been no archaeological excavation but an analysis of electronic circuitry. Topological configurations (be it micro-circuitry, be it the infrastructural and protocol webs of the Internet) are the "field" rather than "layers" for media archaeological research.

A geologically notion of "deep time" of the media (even beyond Siegfried Zielinski's time frame for audiovisual media[457]) even goes down to mineral excavations, enriching media archaeology with ecological concerns. Once more, though, the archaeological metaphor prevails, when Jussi Parikka's *Geology of Media* (2015) which takes a material perspective on contemporary media culture in terms of ecological temporality, is described as "a media excavation" into the raw material basis of technological development.[458]

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456 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
457 Siegfried Zielinski, Deep Time of the Media: Toward an Archaeology of Hearing and Seeing by Technical Means. Cambridge (MIT Press) 2008
458 Jussi Parikka 2012, quoted here after: Michael Goddard, Opening up the black boxes: Media archaeology, 'anarchaeology' and media materiality, published 28 April 2014 in the online journal: New Media & Society, http://nms.sagepub.com/content/early/2014/04/27/1461444814532193. On the "deep time" of media Infrastructure, see: Signal Traffic. Critical Studies Of Media Infrastructures, edited by Lisa Parks and Nicole Starosielski, Urbana, Chicago and Springfield (University of Illinois Press) 2015

Radical media archaeology - in its technically "grounded" version - takes its departure from technology itself. It concentrates on the epistemological insights which can be derived from the close analysis of electro-mechanical artifacts, electronics, and finally computational machines; literally "fundamentally", media archaeology takes the *arché* at its mathematical face value: algorithmic rooting in numbers. The *logo* of media archaeology therfore is the quare root symbol "√".

Even the traditional academic science of Archaeology is not concerned exclusively with the material artefact unburied from the ground any more; a radical mathematisation of archaeological findings (in the early days of computing within the Humanities) has taken place. The challenge of "big data" avalanche and complexity nowadays can be mastered with by computational probabilities in a nonlinear way; here Digital Humanities (or computational philology) becomes a twin method to Media Archaeology. Digital Humanites, in its algorithmic approach, is operative "cultural analytics" (Lev Manovich), displacing the more discursive "cultural studies". Sociologist Gabriel Tarde, in nineteenth century Paris, once defined „deux sortes de recherches que notre temps a mises en grand honneur, les études archéologiques et les études statistiques"; the statistician „jette sur les faits humains un regard tout abstrait et impersonnel"[459] - which is a non-human perspective on human culture.

Walter Benjamin, in 1936, still compared the camera-man to the surgeon, just as Foucault focused on the clinical gaze.[460] In its radicalized operation, the *media*-archaeological gaze converges with technological *imaging* itself - like an optical scanner recognizes the material artefact, and the so-called "imager" is a device for deciphering QR-codes. Here, the very term technology unfolds in its literal sense, reminding both of material hardware manipulation (*techné*) and its coded operations (*lógos*).

Media archaeology refers to *both* aspects: the physical artefact (ancient Greek *techné*), *and* its mathematical analysis (*lógos*) when it comes to computational devices, which makes the composite term "techno/logy".

The application of techno-mathematical tools of analysis to archaeology[461] results in media-*active* archaeology, not reducing technological artefacts to their materiality but transcending it towards the mathematical.

Computer archaeology: case *E. T.*

Media archaeology is not just a theory but a research method as well; therefore its character is object-oriented and operational.

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459 Gabriel Tarde, Les lois de l´imitation, Paris 1890, chap. IV (Qu´est-ce que l´histoire?), section „L´Archéologie et la Statistique", 99 and 114
460 See Markus Buschhaus, Über den Körper im Bilde sein. Eine Medienarchäologie anatomischen Wissens, Bielefeld (Transkript) 2005
461 See F. R. Hodson / D. G. Kendall / P. Tautu (eds.) Mathematics in the Archaeological and Historican Sciences, Edinburgh / Chicago (Edinburgh University Press / Aldine Atherton), 1971

What separates computer archaeology from previous technologies is its double focus on both hard- and software. The obsolescence of past computing can not be reduced to the naive understanding of digging out its residual materialities, as has been suggested by the spectacular digging for Atari computer game cartridges a few years ago The antique computer game *E. T. - The Extraterrestrial* (1982) has become the target of a soft and a hard way of practicing media archaeology. Ironically, the soft version concerns hardware, and the hard version concerns software.

The economic failure of the computer game *E. T. - The Extraterrestrial* (1982), in the collective memory of media culture, has triggered the first crisis of that industry, leading to the literal "dumping" of both its hardware in the desert of New Mexico in 1983, almost returning silicon chips to elementary silcon (sand) - until it has been archaeologically re-discovered in 2014.[462] But different from the classical cultural museum object, such technological devices - which are in a medium state only when processing signals - requires a new form of *processual media archaeology*.

The real "excavation" of computational devices is going to the roots of the programming code within, which requires disassembling machine-readable code in radical technomathematical media archaeology.[463] Digital forensics is a twin to Media Archaeology when tracing data from erased or damaged computer hard discs; not by coincidence, it has been a scholar familiar with textual criticism, Matthew Kirschenbaum, who introduced digital forensics into Media Studies.[464]

"Dead media" archaeology as artistic research

Media artist Garnet Hertz produced a book which in the spirit (and explicitly "in memory") of Bruce Sterling's *The Dead Media Handbook* initiative from 1995. The exuberant title of Hertz' book aligns itself with the "antiquarian" discourse of the 18th century: *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., Wherennto is added, Dead Media.*[465] Singling out by chance (that is: by random access) any of such items, we find e. g. the drawing of a geometrical system for the measurement of dimensions, apparently from the late Renaissance, or the switch-board of an early computer installation in an office.[466] Sterling's original "Dead Media" project had been

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462 For photographies from this excavation, see https://en.wikipedia.org/wiki/Atari_video_game_burial (accessed November 10, 2017)
463 See http://adamsblog.aperturelabs.com/2013/01/fun-with-masked-roms.html; accessed July 10, 2014
464 Matthew Kirschenbaum, Mechanisms. New Media and the Forensic Imagination, Cambridge, MA (The MIT Press) 2008
465 Telharmonium Press in Hollywood, California, 2009
466 http://underbelly.nu/product/a-collection-of-many-problems (accessed November 10, 2017)

intended to result in a book but started and ended with an online archive, finally disappearing into the Internet archive itself.[467] Consequently, Hertz' monument to Sterling's "Dead Media" project itself re-aligns with the more reliable chance for enduring knowledge in the Gutenberg era. The printed book text and illustrations are technically authorized by material supplements, like scraps of paper stripes with embossment which apparently is Morse code. But what is declared as "dead media", in this case can principally be re-enenacted (thus: deciphered, read, sonified) today, just like the mesaurement instructions are mathematically valid still, and the switch-board continues in present day computing, though in alternative miniaturized forms. Melancholy is the expression of nostalgia for something we long for but can not reach any more, since it is entropically (irreversibly) gone. The media-archaeological approach is non-melancholic, though.[468] Past media are undead, principally (*en arché*) re-enactable and thus in a potential state of latency, of time delay (Delta-*t*). Media-archaeological artefacts are embedded in another temporal logic which defies historisation. As long as they are not operative, they remain in "museal" latency; at any moment, though, they can be reanimated, like signals as a function of time.

II ON MEDIA ARCHAELOGY (notes):

"Cultural techniques" vs. techno-mathematical operations

- a technical medium based on cultural knowledge, but still of a physical nature because there are electro-physical laws at work that are not solely dependent on the respective cultural discourse; media implement knowledge of physical and mathematical laws that both result from and transcend cultural knowledge; technology emerging *from* culture as an autonomous entity *beyond*

- "Mathematical symbols <...> have a particularity: they reveal structures"[469], in fact: they become media-archaeological operators themselves (*poiesis*)

- "Radical" media archaeology literally referring to the mathematical square root; techno-mathematical analysis is the cutting edge of rigid media archaeology (in accordance with Foucault's *Archaeology of Knowledge* which is much closer to propositional mathematics than most readers - apart from Martin Kusch - admit); mathematical approach, in combination with close electrotechnical analysis, is what differentiates "digital culture" analysis from previous media (studies)

467
https://web.archive.org/web/20071019055700/http://www.deadmedia.org/notes/index.html (accessed November 10, 2017)
468 See definition of "Media Archaeology" in
    https://en.wikipedia.org/wiki/Media_archaeology; accessed November 30, 2017
469 Max Born, Symbol and Reality, in: Objectivité et réalité dans les différentes sciences, Archives de l'Institut International des Sciences Théoretiques, Brüssel 1966, 151 f.

- very term "technology" consisting of two parameters. Athanasius Kircher, Phonurgia Nova, New York 1966 (Reprint edition Kempten 1673; German transl.: Hall- und Thon-Kunst, xxx; lat. *medium* there transl. with "Mittel" bzw. "Behülf"; difference between instrument and techno-logical medium. Kircher p. 12: "Duplex hoc loco medium considerandum est, Physicum, & Mathematicum. Physicum medium est spatium illud aereum, per quod vox propagatur, diversaeque qualitatis & constritutionis est. Mathematicum medium est magnitudo, vel parvitas intervalli propagatae vocis durationem mentis [...]."[470] A second-order *medium* is knowledge-appropriated physics; the media condition for such appropriation is the construction of arbitrary, exact measuring device, such as tubes to measure acoustic reverberations: the interlacing of nature and culture, literarate techno-logy

- "Humans *as such* do not exist independently of cultural techniques of hominization, time as such does not exist independently of cultural techniques of time measurement, and space *as such* does not exist independently of cultural techniques of spatial control"[471]; concept of "cultural techniques" providing a way for German media theorists to move away from the anti-humanist tendencies in Kittler's work and to focus instead on cultural practices: "The culture-technical approach offers a viable alternative or escape route. To speak of operations and connections allows those inspired by the Kittler effect to speak of practices without saying society; to readmit human actors allows them to speak of agency without saying subjects."[472] Kittler's anti-hermeneutic stance thus transformed "into a less intransigent post-hermeneutic approach involving certain notions of praxis and limited human agency that Kittler was prone to eschew."[473]

- concept of cultural techniques rooted in agricultural practices like alphabetic writing *boustrophedon*

- contemporary technological mediascape not simply progressive escalation or recursion of previous cultural techniques in Hegelean dialectics but new quality; rather delegation to the techno-logical *(auto-)poiesis*: pulling the Pythagorean string experimentally a direct human-instrument-coupling, while with VCO (voltage controlled oscillators) in electro-acoustic synthesizers a technological world inbetween unfolds; well-tempered tuning as non-Pythagorean sound (Johann Kroier) in current electro-acoustiv synthesizers is not coupled to the tuning human hand any more but "stammt aus einem Netz von zwölf ziemlich teuren Metallfilmwiderständen, die die Oktave als Einheitspotential und ihre zwölf Halbtonschritte folglich als 2^-12 Volt <sic> behandeln."[474]

- cultural techniques *performative*, body-related action, "extensions of men" in McLuhan's sense, vs. media-technological *operations* which have escaped

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470 Ambivalences in Kircher's use of both categories is discussed in Hoffmann 2002: 66 ff.

471 Siegert, "Cultural Techniques," 57

472 Winthrop-Young, "Cultural Techniques," 14.

473 Ibid., 15.

474 Friedrich Kittler, Phänomenologie versus Medienwissenschaft, online http://hydra.humanities.uci.edu/kittler/istambul.html, Abruf 22. Januar 2018

phenomenological reasoning since Maxwell's mathematical calculation of the electro-magnetic field, "withdrawn from any insight or introspection"[475] which only comes in again on a symbolical machine level, the non-opaque coding of computers

- nonlinear media-"historic" short cuts; Media Science not starting with the Pythagoren monochord, but abbreviates genealogy with electric spark (Aitken), generating oscillations; Hertz' Karlsruhe lecture room experimentation with electromagnetic waves / resonators: an inbetween acts, genuine media-event

- meaning of *realtime* actually not temporal fidelity (indexicality) but a tempo*real*. Norbert Wiener's "time on non-reality" for the binary switch; escalation of technologies from cultural techniques into the time-critical regime, the qualitative transformation from "performative" (body-and-cognition related) to "operative" (van Treeck)

On transmission as "bridging"

- John Durham Peters, *Marvellous Clouds*: difference between cultural techniques and technologies; corresponds to the difference between material bridging, electro-magnetic relays, and transmission by electro-magnetic waves; core scene of Bertolt Brecht's *Lindberghflug*, true media theatre in 1929 = draft paper by Marcus Bastos, "On Transmission: bridging the 19th and 21st centuries", February 2018. Lindbergh's airplane material transportation, whereas radio wave transmission "bridging" in terms of resonance. While the material bridge is stable, electro-magnetic bridging is vibrating itself, a repetitive temporal process. While material transportation means delay in transmission (the actual flight time), immaterial radio transmission allows for "transmitted presence" or "mediated presence" indeed. For doors, the difference between technique and technologies is human opening / closing vs. the electro-magnetic relay for switching circuits and binary 0 / 1 decisions. A sharp techno-epistemic rupture occurs with net-based communication media (embodied in "packet switching" in Internet communication when the original unity is fragmented with individual addresses to find their way through parallel server routing): no *one* bridge any more, not one point-to-point connection, but a multiplicity of radically temporal, volatile, ephemeral bridges which exist only for the moment of partial signal transmission

Media, mathematics, archaeology

- Hilbert´s meta-mathematical theory leading to a non-referential use of mathematical signs: simply operative, thus engineerable, resulting in Turing's conceptual invention of a paper machine for calculating algorithms in 1936

- no more humans that explore the deep Universe like Galilio Galilei with his telescope; eye not the fastest channel of acquiring knowledge, as expressed by

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475 Friedrich Kittler, Observations on Public Reception, in: Radio Rethink. Art, Sound and Transmission, ed. by Daine Augaitis / Dan Lander, Banff (Walter Phillips Gallery) 1994, 75-85 (80)

Goethe in *Dichtung und Wahrheit*, but the word: "Das Auge mag wohl der klarste Sinn genannt werden, durch den die leichteste Überlieferung möglich ist, Aber der innere Sinn ist noch klarer, und zu ihm gelangt die höchste und schnellste Überlieferung durchs Wort, denn dieses ist eigentlich fruchtbringend"[476]; words have excalated into data strings in algorithmically coded machines, in the programming of the computational executions which are the hidden agencies behind all apparent interface iconicity and metaphors

- media archaeology analyzing the techno-logical negotiations and reciprocity between mathematization of machines and machinization of mathematics itself. Any archaeology of the computer and its programming practice oscillates between these two poles. Almost like a transistor itself, the materiality of mechanics and electronics at the same time enables and resists to pure *mathematical procedures* (Kurt Gödel).

- "Simple mechanics may be able to implement simple calculating rules or algorithms, such as the four-species-machine which the young Leibniz presented to an astonished Royal Society, successfully translated the Indian-Arabic counting system by ciphers into a hardware of decadic cog-wheels, thus for the first time automating the primary counting modes. But this flow of numbers between mechanical wheels has simply be a calculation but noch yet a program which would be able to start, control and finish calculations on its own account. Historically programing only started - as opposed to calculability - at the time when technologies changed from tools to machines."[477]

- *logic of engineering* one aspect of technology and another one *the engineering of logic* such as the building of logical machines[478]; integrate philological and historical aspects of computer archaeology on the one hand and scientific and engineering aspects on the other under the perspective of *cultural engineering*. Such techniques comprise not only texts and images, but numbers as well; true media archaeology close to mathematics, replacing the historicist quest for temporal origins by the mathematical quare root symbol (for *arché* itself)

- Martin Kusch's reading of Foucault´s *Archeology of Knowledge* with its key terms like "series", "enunciation" etc. as the language of propositional logic; rendering these passages intelligible therefore is "to take the notion of a function at its mathematical face value" = Martin Kusch, Discursive formations and possible worlds. A reconstruction of Foucault´s archeology, in: Science Studies 1/1989, 17-25 (17), which is radical media archaeology in its purest

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476 Quote here after: Wolfgang Iskra, Die Darstellung des Sichtbaren in der dichterischen Prosa um 1900, Münster (Aschendorff) 1967, 41

477 Friedrich Kittler, Hardware, das unbekannte Wesen, in: Lab. Jahrbuch 1996/97 für Künste und Apparate, edited by the Academy of Media Arts, Cologne 1997 (Walther König), 348-363 [transl. W. E.]. Related to this argument, see Peter Berz, 08/15. Ein Standard des 20. Jahrhunderts, Munich (Fink) 2001

478 See the contribution by Gellius N. Povarov, Logic, automation and computing, to Georg Trogemann / Alexander Nitussov / W. E. (eds.), Computing in Russia. The history of computer devices and information technology revealed, Braunschweig (Vieweg) 2001

form. In the Pythagorean tradition, Friedrich Nietzsche once mused upon the relation between mathematics and nature; embodied in technological artifacts, numbers have indeed became autonomous.[479] With algorithmic computing comes true what Nietzsche has declared.

Answers of Media Archaeology to Cultural Techniques Studies

- counter-reading of the "hands on"-approach, accentuating the suspension of man from the "handy" relation to the world by technical machines, apparatuses and automata, beyond *Kulturtechniken*. Media archaeology keeps an ascetic analytic distance against the anthropological and discursive focus of Society and Technology Studies, concentrating rather on the non-discursive constellations which define the human-machine relation - at the expense of the "human technology which exists before a material technology" (Deleuze 34), the diagrammatical prefigurations of technologies by the diagrams of cultural engineering.

- transitive hand-machine relations subsumed under the field of studies called "cultural techniques" (German "Kulturtechniken")[480], remaining somewhat anthropocentric; media archaeology with its focus on the non-discursive human-machine constellations keeping a more ascetic distance to the human agency in favor of the techno-mathematical field itself; for the purposes of such an analysis, the socio-cultural discourses that envelop technological processes momentarily suspended

- hermeneutically distant look and "cold gaze" for media archaeology para-human in terms of Walter Benjamin's comparison of the camera man (brilliantly expressed by Dziga Vertov's film *Man with a Camera*) with the operative gaze of the surgeon[481]

- human culture not losing, but winning by non-semantic challenge, when suspended from subject-centered intepretations for a moment. Media archaeology exposes technicality of media not reducing culture to technology but revealing the techno-epistemological momentum in cultural artefacts itself

- Deleuzean concept of the machine as "organless body": "simultaneouly and inseparably a machinic assemblage and an assemblage of enunciation" = Gilles Deleuze / Félix Guattari, A Thousand Plateaus: Capitalism and Schizophrenia, trans. Brian Massumi, Minneapolis 1987, 504 / "a site at which a discursive formation intersects with material practices" = Jonathan Crary, Techniques of the Observer: on vision and modernity in the nineteenth century, 2nd printing, 1991, Massachusetts Institute of Technology 1990, 31

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479 "`Die Zahlen haben sich verselbständigt.`" Martin Stingelin, in: Kunstforum Internatnational, vol. 155 (2001), 166
480 See Theory, Culture & Society, vol. 30, no. 6 (November 2013), Special Issue *Cultural Techniques*, edited by Jussi Parikka / Geoffrey Winthrop-Young
481 See Walter Benjamin, Das Kunstwerk im Zeitalter seiner technischen Reproduzierbarkeit [1936], Zweite Fassung, in: ders., Gesammelte Schriften, hg. v. Hermann Schweppenhäuser / xxx Tiedmann, Frankfurt/M. xxx, Bd. xxx, 474- (496)

- all the difference between hand-writing and type-writing (Heidegger)

- phonetic alphabet (cultural technique) vs. phonograph (the actual acoustic signal) vs. spectral voice analysis / synthesis (re-entry of symbolic code, implemented and thereby temporalized in electro-physics)

- technical signal recording not a cultural technique any more but physical event. The recording of the acoustically or optically "real" physical signal is opposed to symbolic notation by the alphabet not only in a technical but also in an epistemological way: the difference between physical signal as indexical and the arbitrary cultural symbol. With computing, dialectic opposition becomes synthesized; Digital Signal Processing (notably sampling of audio events) a function of discrete symbolization, a re-entry of the "alphabet" in numerical and logical form

- ancient Greek vowel alphabet, distinct to other writing systems, "invented" not only to write down Homer, but engendered operative mathematics, "thus, to science as such"; this very vowel alphabet of the Greeks has be/come (again) closer to new media than most of the other languages, such as roman scripts, since letters in the vowel alphabet could also be numbers and the codes of new media is now alpha-numeric, embodied in binary digits = Axel Roch, Hegel is Dead: Miscellanea on Friedrich A. Kittler (1943-2011), in: Telepolis (November 17, 2011); http://www.heise.de/tp/artikel/35/35887/1.html (accessed June 26, 2017)

- according to Walter Ong, electronic revolution in mass media communication devices like radio and television resulting in "secondary orality", communication based on the symbolic machine (computing) has led to a (hidden) secondary alphabetic revolution, with bits and bytes inheriting the typeset, but different from the printing culture in a dynamic way. The voice turns silent and still articulates - in implicity mathematical sonicity which is the ultimate shock to occidental logocentrism

- a resonance circuit (the electronic basis of oscillators for electronic music synthesizers) not a cultural technique but a physical event of second (culturally intelligent) order

- beyond the reach of "cultural techniques": When the inscribed phonographic traces on wax cylinders from Edison's days are opto-digitally retraced, inaccessible sound recording becomes audible again.[482] Frozen voices, once confined to analogue and techno-archivally secluded storage media, wait for their (digital) unfreezing. In that media-archaeological analysis, "media are the new capital-s subjects of media archaeology [...]"[483]

- physical and electromagnetic laws known to the designers of a *Volksempfänger* from pre-war Germany still in operation in today's enduring AM radio infrastructure. "Mathematically encoded laws of nature, then, occupy the

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482 See Patrick Feaster, Pictures of Sound. One thousand years of educed audio: 980-1980, Atlante, GA (Dust-to-Digital) 2012
483 Winthrop-Young, Siren Recursions, in: xxx

place once held by the place of the music of the spheres."[484]

- inductive rather than meta-discursive argumentation; media archaeology radically rooted in the actual techno-logical event

- cultural techniques (such as writing and counting) as pre-condition for technological escalations; an escalation not simply an extension, but a new quality. Cultural techniques are related to the arbitrariness of the human hand / body / action, while technological implementation into electro-physics enables a techno-sphere below human "historical" (Vico) culture

- conceptually, cultural techniques still within the time-field of cultural history: Vico's man-made temporality, while media archaeology claims that media, when in operation (instead of being simply material things), constitute their Eigenzeit.

- according to Giambattista Vico, history as temporality which humans understand for what their culture has produced itself, different from natural evolution. Autopoietic techno-mathematical time is an interlacing of both temporal regimes. Even if technologies are products of human culture, they generate non-historical figures of temporality (standardized clocking time) which irritate humans accustomed to / by the narrative discourse of time-telling

- concept of cultural techniques for *Kulturwissenschaft* what radical media archaeology is for *Medienwissenschaft* (both written in singular)

- technology as culturally, i. e. symbolically (re-)defined physical nature / (electro-)physics, mathematically folded upon itself (such as so-called "cognitive radio")

Modelling electric circuit diagrams

- retrospectively from today's omnipresence of the "flipflop" in binary computing, "first" diagram of a digital switching circuit has been the Eccles-Jordan trigger; rather media-archaeological *ur-* (ongoing *arché*) than "original" in the historical sense: the trigger relay; cp. Bonch-Bujevich 1918 = "gleichursprünglich"

- discrete computing ultimately boils down "to signifiers of voltage differences" = Friedrich A. Kittler, There is No Software, in: same author, Literature, Media, Information Systems: Essays, ed. John Johnston, Amsterdam (G+B Arts International) 1997, 150

- circuit diagrams mixtures of iconic signs, indexical signs and symbols; interrelating switching and interpretation. "But [...] do you see a digital device? Do you see an analog device? Is it a matter of interpretation? A historian of electronic media would read this diagram in a way that would locate that diagram within the history of radio: After all, what we have here basically is a grid electrode which is modulated by a signal. What strikes at once is the

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484 Winthrop-Young, op. cit.

similarity this circuit has to Edwin Armstrong's Audion amplification circuit of 1913. [...] The principle is that of a relay: the feeble input signal that is applied to the grid is amplified by a feedback of the strong oscillations in the anode circuit. A highly instable device, though: If the feedback became too strong the whole apparatus turned into a oscillator, i.e. a transmitter. [...] 'Signals that are scarcely audible with the ordinary audion connection can be amplified to a point where they are too strong for, *and 'paralyze' the most stable audions*'. In the Eccles-Jordan trigger this pathological bias became the one and only purpose" = TS Siegert (IKKM discussion), referring to Edwin Armstrong, Patentschrift 1,113,149, Patent abstract, p. 2

- replacing the historicist quest for "beginning" by structural principles ("archi-tectural") *arché* which is operational timings rather than chronological origin; "if we take care to identify the digital as a condition that is made possible by the conceptual foundations of digital media and not necessarily by digital media itself, the boundaries of the digital moment—when it began and under what circumstances—become less clear" = announcement of book launch of Andrew Goodhouse (ed.), When is the Digital in Architecture?, at: Spike, Berlin, 15 June, 2017 = media archaeology in the Kantean / Foucauldean sense (*a priori* / *l'archive*); the pre-"digital media" conditions of "the digital" = rather cultural techniqus of counting and discrete numerical / measuring operations

- "Suppose the analog simulation is an electronic one, built out of resistors, capacitors, op-amps, VCOs, filters, and the like (simulation, perhaps, some complex mechanical harmonic system). Now imagine constructing a *separate* symbolic simulation of each of these components, attaching them all to the approporate anlog-digital and digital-analog converters, and then connecting the restuling 'black boxes' together with just the curcuit topology of the electronic simulator. <...> we have here 'isomorphism of causal structure'" = report by anonymous referee for *Philosophy of Science*, quoted in: Russel Trenholme, Analog Simulation, in: Philosophy of Science, 61 (1994), 115-131 (121); for such a component-by-component replacement of analog elements with symbolic subroutines "we must be able to provide a physical description of these subprocesses" = 121; claim for simulation (not just functionally emulating) the ENIAC computer with SIMULINK-based modelling the idiosyncrativ behaviour of single electronic tubes themselves

- Ihnatowicz' re-translation of digital data into analog computing, to increase the speed of his installation. "Fortunately, the circuit diagram for the predictor survives and was simulated using SPICE, a standard circuit simulation software package" = Paul Brown, Charlie Gere, Nicholas Lambert, and Catherine Mason (eds.), White Heat Cold Logic: British Computer Art 1960 - 1980, Cambridge, MA (MIT Press) 20xx, pdf 118

- Kittler's (phantom) Harmonizer necessarily embodying a digital (thus "symbolic") processor to calculate vocal frequencies in real-time - just like the first digital image processing was embodied in video recorders

- "Symbolic simulations are individuated by the *theory* that is modeled on the computer, and analog simulations by the *simulation device itself* <...>" = Trenholme 1994: 120

Cultural techniques vs. technological idiochronicity

- rivalling with the concept of *Kulturtechnik* (cultural engineering), term "technicity" as defined by the Gilbert Simondon, to trace the force, effectivity and performativity of cultural transformation *intrinsic* and *prior* to tools, apparatuses, media technologies and other technical assemblages; Andrea Bardin and Giovanni Menegalle, Introduction to Simondon, in: Radical Philosophy 189 (Jan/Feb) (2015)

- technological media not completely subjected to an all-embracing cultural history, but tend to develop a temporality of their own; not just historical techniques but as well material "logic" which escapes historization; when nowadays Pythagorean experience reenacted at monochord, medium itself regenerates an equiprimoridal temporal position to such a time-invariant diagrammatic argument; implicit operative knowledge within media themselves waiting to be discovered by humans (different from performative, human body-bound "tacit knowledge" defined Polyani)

- different from historical hermeneutics (and within humanities as *Geisteswissenschaft*), replica of a material experiment in the past allowing for its understanding by reenactment even if the replica is not the original materiality but a functional equivalent - which is different from the limits of understanding for knowledge coded in written documents; technological object is an operative "source" of past knowledge; Christian Sichau, Die Replikationsmethode: Zur Rekonstruktion historischer Experimente, in: P. Heering / F. Rieß / C. Sichau (eds.), Im Labor der Physikgeschichte. Zur Untersuchung historischer Experimentalpraxis, Oldenburg (Bibliotheks- und Infomrationssystem der Universität Oldenburg) 2000, 10-23 (10, note 3)

- Sotheby's auction object no. 61 "THE FIRST ELECTRIC SOUND SYNTHESIZER. A HELMHOLTZ SOUND SYNTHESIZER, MANUFACTURED IN CHEMNITZ BY MAX KOHL AFTER THE DESIGN BY HERMANN VON HELMHOLTZ, CA 1905 = http://www.sothebys.com/en/auctions/ecatalogue/2017/history-of-science-technology-n09686/lot.61.html; "History of Science and Technology" category; replicas of such instrument for an active experience of media archaeological analysis by material synthesis

- Sotheby's catalogue, number 62, the legendary Theremin: TELETOUCH THEREMIN POSSIBLY BUILT BY LÉON THEREMIN, CIRCA 1937-1938; functional replica of its developed version Terpsiton; even carried further by software augmentation to turn it beyond a playful experience of intuitive interactive interface into a knowledge machine, coupling it with ancient Greek musical scales; raises the question of media-archaeological authenticity; computer preservation has enriched the discussion by introducing the concept of (functional) emulation, as an alternative to historicist simulation

- historic / ahistoric double-bind of techno/logy: time-invariant logical reasoning vs. radically "historicized" physical implementation. Donald F. McLean's paper "The Achievement of Television: The Quality and Features of John Logie Baird's System in 1926", in: The International Journal for the History of Engineering & Technology, Vol. 84 (2014), Issue 2, 227-247, inspired an engineer to build a

version of the Baird Double-8 apparatus (uses a Nipkow disc with two spirals of 8 lenses, used by Baird in 1925 as a transportable demonstrator). McLean predicted it would be less quality than single-spiral Nipkow disc device. "It would seem from tests on the model that it was *significantly* poorer quality. Therein lie the benefits of 'hands-on' experimentation. The 'devil is in the detail' and building something forces the detail (and the devil!) out" = expressed by Donald Mclean, September, 2017; M. Groth / S. Höltgen, Wissens-Appa/Repa/raturen. Ein epistemologisch-archäologischer Werkstattbericht von der Reparatur eines fruhen Mikrocomputers, in: Krebs, S. et al. (eds.), Kulturen des Reparierens. Dinge – Wissen – Praktiken, Bielefeld (transcript) 2018

- Michel Serres distinguishing between techniques and technologies; distinction applies to the difference between cultural techniques and media technologies, between energetic / material machines and informational electronics / computing; Norbert Wiener contrasts the "hard" machinery of the Industrial Revolution, functioning on the basis of thermodynamics, with the "soft" negentropy of information technology - just like the difference between a steam engine and a thermionic tube: "I therefore reserve the term 'technology' for those types of artefacts that negotiate signs - and thus the logos - and contrast them with 'techniques', whose energetic scope is 10^{16} times higher"[485], just like German engineering since Heinrich Barkhausen (as pointed out by Norbert Wiener) differentiates "Starkstromtechnik" (current used as energy, like heating) from "Schwachstromtechnik" (low curreny) where subtle amount of electricity is used for communicational rather than energetic purpose - which equals the difference between electricity and electronics; thermionic tube (triode) allows for technological intelligence. No more transitive cultural technique but "second machine" age (Gotthard Günther)

- concerning the frequent confusion between the stroboscope and the afterimage effect in the transmission of visual perception, Bernhard Siegert insisting "how fundamentally the media-theoretical discourse is in need of a media-historical framework of analysis to match media's inherently high physical and mathematical standards"[486]; media archaeology not merely reconstructing historical media practices, also reflects on their time-building, chronopoetic processes

Technological media processes within/-out Cultural History

- postal system (transmission) and the archive (storage) conjoined when Erich Moritz von Hornbostel ordered Edison cylinders with ehtno-musical recordings from all over the world for his Berlin phonographic archive, with the scope of developing the field of comparative ethnomusicology.[487] Chronology, diplomacy,

485 Michel Serres, *Der Mensch ohne Fähigkeiten. Die neuen Technologien und die Ökonomie des Vergessens*, in: Transit 22 (Winter 2001/02), 193-206 (194f). [Transl. by GS]

486 Bernhard Siegert, Good Vibrations. Faradays Experimente 1830/31, in: Kaleidoskopien Heft 1/1996, 6-16 (8). [Transl. by GS]

487 See Sebastian Klotz (ed.), „Vom tönenden Wirbel menschlichen Tuns": Erich M. von Hornbostel als Gestaltpsychologe, Archivar und Musikwissenschaftler,

epigraphy, genealogy, heraldry, numismatics, palaeography, sphragistics, historical cartography: so-called ancillary disciplines of history, which identify and analyse their objects with regard to their usability as cultural data storage devices, acquire the status of media archaeology *avant la lettre*; culture a function of mnemonic strategies and transmission techniques

- discover the specific inner temporality [*Eigenzeit*] of technologies; media archaeology conducting analysis not on the level of macro-cultural production, but rather on the level of micro-technical operativity; elementary, sub-semantic procedures. Material, symbolic and signal-based operators are not just escalations of classical cultural techniques; they require a theory of genuine media-temporal processes

- "organ projections" and the *extensions of men* (Ernst Kapp, McLuhan) have developed into cultural servomechanism

- man as codified (or even programmed) by cultural techniques and media technology; media theory actively pursuing the "antiquation" of man (Günter Anders) by distancing the subject-centred perspective through apparatus-based *theoría*

Media-temporal processes and their break from cultural history

- segment titled "Movement and Time" in Gustav Deutsch's film *Film ist* [Film Is] (Austria, 1998): medical X-ray footage of a speaking larynx; the medium speaks for itself, producing the same effect as the invention of the vocal alphabet in ancient Greece, which not only created the possibility to record – and thus store and transfer – oral poetry as a stream of phonetic utterances, but also allowed objects like drinking vessels and tombstones to speak to the reader in the first person via their inscriptions; scientific observation of a speaking larynx in sets of 12 to 24 X-ray images per second no longer conditioned by the human eye but by the eye of the camera or even that of the X-ray cathode. Only technical media are capable of manipulating, decelerating and accelerating moments such as this in a time-critical manner; *Film ist* announcing the media–archaeological level in the existence of the apparatus

- "There was a time when archaeology, as a discipline devoted to silent monuments, inert traces, objects without context, and things left by the past, [...] attained meaning only through the restitution of a historical discourse; [...] in our time history aspires to the condition of archaeology, to the intrinsic description of the monument."[488] As functions of a process of transmission, technologically generated signals are messengers of other things; at the same time, every electronic image, every electronically (re)produced sound always also a monument to itself, to its technology and – more radically – to the computer program which created it, amounting to media self-reference; media

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Berlin / Milow (Schibri) 1998, 116-131

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

technology, while clearly emerging from human / cultural knowledge, resulting in an autonomous entity – a process that manifests itself via the technical feedback loop (the cybernetic paradigm of machine and mathematics). The development of feedback routes – as James Clerk Maxwell's *On Governors* (1868) had already shown prior to all explicit formulations of cybernetics – increasingly separates media systems from the discursive streams of culture. Thus, automation is defined precisely by the fact that "human controls have been disabled." [489] When the field of electronic media is accessed in terms of the electromagnetic field, this distinction places technological media in opposition to traditional culture-technical practices; remaining within the terminology of electromagnetism instead of cultural historiography: with media, there is only mutual induction. The discovery of electromagnetism – theoretically posited by Faraday, mathematically calculated by Maxwell and ultimately empirically proven by Hertz – overcame the search for a representation of humanity in nature, and instead defined it as a set of processes that open up a new field between physics and culture. "We must we therefore understand the knowledge of electrical phenomena and their application as an exclusive product of the human intellect."[490] By using electricity, man has surpassed nature, and not simply performed an act of organ projection. "Once it is possible to animate an automaton that is better constructed than man himself, the world has reached its ultimate purpose."[491] The media processes that are thereby set in motion no longer exclusively belong to either nature or culture. The Greek term *nómos* already implies a departure from *physis*, from nature itself.[492] Faraday taught us to understand this field as a form of independent reality with an intrinsic dynamic, detached from the corporeal realm[493], opening up a space for temporal and spatial free play; facing techno-mathematics by its rules, it derives not from cultural history, rather from Riemann spaces, where time and space become conflated. Michelson-Morley experiment from 1887 gloriously failed to prove the existence of "ether wind"; followed by the provocative Lorentz contraction theorem: instruments of measurement expand or contract along with the ether. Although this explanation considered obsolete today, it still holds the appeal of an alternate model of conceptualizing non-historical time in what is called culture

- culture no longer operating with primary natural "media" (air, water) alone and also posits no imaginary substances ("ether"), but rather – as in the case of electromagnetic carrier waves – forms its own media channels that can be both artistically and artificially *modulated*, the combination of media produced by cultural techniques and human speech acts generates the uncanny, siren-like attraction of media technology. Precisely because "the Sirens, who were

489 Klaus Szameitat, Möglichkeiten und Grenzen der Automatisierung in der Statistik, in: Allgemeines Stastistisches Archiv 43 (1959), 316- (316). Translated by Guido Schenkel.

490 Raphael Eduard Liesegangs Das Phototel. Beiträge zum Problem des elektrischen Fernsehens, Düsseldorf 1891, x. Liesegang refers to an entry in: Electricitäts-Zeitung No. 24 (1890). Translated by Guido Schenkel.

491 Liesegang ebd. Translated by Guido Schenkel.

492 Anm. des Herausgebers zu Buch II (§ 371b) von Platon, Der Staat (Politeia), übers. u. hg. v. Karl Vretska, Stuttgart (Reclam) 2001, 503

493 Carl Friedrich von Weizsäcker, Die Einheit der Natur, München (dtv) 1974, 147

only animals [...], could sing as men sing, they made the song so strange that they gave birth in anyone who heard it to a suspicion of the inhumanity of every human song"[494]; temporality of media transmissions inducing a similar discomfort: Hitchcock's *Psycho* a historical film document every time it airs over television channels, but in the technical moment of transmission, it is actively present (unlike a painting in a museum) as an electromagnetically-induced process that shoots through our sense of time like an electric surge; cognitive dissonance: the subliminal perception of the present, but with the cognitive awareness of an alternate perspective, namely that of the past

- technology no longer an organ projection of nature; cultural knowledge negentropic re-configuring products of nature into technological artefacts = Gernot Böhme, Natürlich Natur. Über Natur im Zeitalter ihrer technischen Reproduzierbarkeit, Frankfurt/M. (Suhrkamp) 1992, 118; when musing about the nightingale's song, Kant points out that, in the absence of a bird, men knew to produce such sounding exactly like nature in *dissimulatio artis* (hiding acousmatically in a bush) = Böhme 1992: 119. Once analytical media measure the frequencies of sounds, they are able to synthetically subvert the sonic difference between humans and machines; a radio broadcast of a singing nightingale results in uncertainty wheter recorded in nature or synthetically produced by electronic circuitry; Eduard Rhein, Wunder der Wellen. Rundfunk und Fernsehen dargestellt für jedermann, Berlin (Deutscher Verlag) 1935 (4th ed. 1939). When nature itself becomes reproducible, it is technically legible. The age of the baroque cabinets of curiosities had an impartial view on these matters. Pre-electroic cultural techniques still oriented at nature as "an infinite resource for artificial machines that surpass all human inventions" = Johann Gottlieb Sulzer, Versuch einiger moralischer Betrachtungen über die Werke der Natur, Berlin 1750, 39 (transl. into English by Guido Schenkel). See Horst Bredekamp, Antikensehnsucht und Maschinenglaube, Berlin (Wagenbach) 1993. Radio waves not unnatural (*para physin* – according to Aristotle's *Physics*), rather reproduce the secret of their own wave movement in a generative kind of *mimesis*.[495] Artificial nature is baroque machine culture but becomes obsolete with algorithmic computing; see Böhme 1992: 196. Media-archaeological perspective of the trans-classical machine; culture defined by creating un-natural meaning functions (Flusser); operational logic of algorithmic machines, even if 100 % product of cultural engineering, neither reproduces natural, nor subjective objects; its *artefacts* are of a techno-logical kind.[496] Culture has not only created signal-processing machines, which are - in the operative moment - then by definition dialectically autonomous from culture. Computers and communication technology do not count (with) semantic aspects; they do not view images as icons; they do not perceive music as sound; they read texts with the aesthetics of a scanner (OCR)[497]

494 Maurice Blanchot, Der Gesang der Sirenen, in: ders., Der Gesang der Sirenen. Essays zur modernen Literatur, München (Hanser) 1962, 9-40 (11). [„The Song of the Sirens", in Blanchot. *The Book to Come.* Stanford U Press, 2003, transl. Charlotte Mandell, p.3]

495 See H. Koller, Die Mimesis in der Antike. Nachahmung, Darstellung, Ausdruck, Berlin 1954

496 See Eggert Holling / Peter Kempin, in: Identität, Geist und Maschine. Auf dem Weg zur technologischen Gesellschaft, Hamburg (Rowohlt) 1989, 138

The Autonomisation of Culture and History: The Micro-Time of Technical Media

- autonomisation of technological processes of media temporality illustrated by the emancipation of mechanical time from astronomical time in the early modern age. Mechanical clocks were more than just that: due to the micro-mechanism of escapement hey became oscillators, bringing the previously celestially-oriented time down to earth. The chronologically discrete clock, in contrast to the category of time as flow, opens up an *éclat* between cultural meaning and operative media; see Ernst Jünger, Das Sanduhrbuch, 2nd ed., Frankfurt/M. (Vittorio Klostermann) 1954. When Nicole d'Oresme compared the movements of the celestial bodies to the rhythms of the mechanical escapement device of a clock in *Le livre du ciel et du monde*, he modelled nature on technical mechanisms instead of modelling technology on organic archetypes. Quarz-driven clockworks finally define time units than the natural cycles (ellipses) in astronomy[498] the mechanical media of time measurement dictate their non-discursive internal temporality to culture and turn the observer himself into their own medium; Galileo suggesting that Christiaan Huygens should not to use the human heartbeat, but rather mechanical oscillations in order to measure time; end result is the atomic clock, which is based on the oscillations of a Caesium isotope; atomic clocks defining chronological units now; emancipation of the media of measurement from nature within physics itself. If time is that which is measured with a clock (the Aristotelian definition of time), then it is media time; category of media history is turned inside out, becoming a temporal fold

- autonomisation of the technological media sphere from traditional cultural techniques; detachment of *engineering* from classical *techné* by mathematization; beyond simple "extensions of man", communication engineering as complete detachment of technical constructions natural or organic modes of operation; Wolfgang Krohn, preface to: Edgar Zisel, Die sozialen Ursprünge der neuzeitlichen Wissenschaft, Frankfurt/M. 1976, 25. Mathematical instruments and clockworks no longer extensions of human organs, rather *organon* in the Aristotelian sense, as "machines whose operation is only guaranteed by their compliance with their own internal laws and rules that can be verified and controlled" = Serge Moscovici, Essai sur l´histoire humaine de la nature, Paris 1969, 220 (transl. into English by Guido Schenkel); see Eleonore Kalisch, Konfigurationen der Renaissance. Zur Emanzipationsgeschichte der ars theatrica, Berlin (Vistas) 2002, 194 f.

- in computational theory, algorithm an ordered progression of step-wise problem solving equals the machine itself. Even if both (logical and material) machines 100 % a product of human knowledge, they develop an intrinsic *Eigenzeit* as media technology where the real message is not the cultural content which is processed but as well something within the non-human world. With the "escapement" in mechanical clock, periodic oscillations becoming a

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497 See Claus Pias (ed.), Kulturfreie Bilder. Erfindungen der
    Voraussetzungslosigkeit, Berlin (Kulturverlag Kadmos), forthcoming
498 See Rudolf Taschner, Der Zahlen gigantische Schatten. Mathematik im
    Zeichen der Zeit, Wiesbaden (Vieweg) 3rd ed. 2005, 56

non-human processual object (emancipating from heart beat) as a function of such techno-logics

- a radio receiving a broadcast, regardless of whether this radio is an old or a recent model, the broadcast always taking place in the present. In contrast to media history – that is, the human vantage point (Vico) – media archaeology tentatively adopts the temporal perspective of the apparatus itself – the aesthetics of micro-temporal processes. A different kind of temporality is represented here. The oscillating string of an instrument still forces its sound – and with it its (intrinsic media) temporality – upon human ears, even if culturally predetermined; differentiation of the acoustic (physics), and the sonic (cultural conditioning); string-based octaves always short-circuiting historical time.[499] This also means that the human senses do not only conform to a seemingly immediate history of being, but also to the instrumental medium itself; such instruments products of cultural techniques; that is, of a negentropic desire, such as the repeated acoustic experiment, in turn inscribed with a "historical" index which combines with human perception – media time, not history, at work here; contingencies in the success of technical discoveries defying narrative logic; Oerstedt coming upon the effect of electromagnetic induction rather by accident during a lecture in which the magnetic needle began to twitch in the vicinity of an electrified wire. Here, a micro-temporal process forms the foundation for a media-technological event and thus produces a new form of temporality in competition to the historical event. Sparks produce waves. Heinrich Hertz, a student of Helmholtz, realized accidentally that parallel to a spark, another one forms – a remote effect of electric beams. Hertz describes this phenomenon with the very mathematical theory of electromagnetic waves which Maxwell contributed to epistemology. Maxwell arrived at the theory of light as electromagnetic waves through pure mathematics; heuristically, however, his very concrete starting point has been Faraday's experimental discovery of electro-magnetic induction. From that epistemological constellation derives the media of electromagnetic waves (television, radio, mobile phones): a realm within its own, no longer simply cultural

- category of resonance between two temporal objects merely taken from acoustics as model; resonance produced when two tuning forks oscillate in perfect harmony. The vibrations of one excited fork – even if interrupted – cause the second to vibrate as well – kind of wireless information transfer[500]; something similar occurring in the actual reading of a "historical" text? If it resonates in the moment of reading, it is no longer historical

How Not to Write Media History?

- media demanding non-historicist modes of representation of their occurrence in time; act of registration (recording) inscribing reversibility into time

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499 See Friedrich Kittler, Aphrodite (Musik und Mathematik Bd. 1.1), Paderborn (Fink) 2006, 282

500 See Eva Küllmer, Mitschwingende Saiten. Musikinstrumente und Resonanzsaiten. Bonn 1986

- technical not merely referring to the axis of time (time-based media), but capable of manipulating it (time-critical media), representing temporal statements. In contrast to historiography and historical monuments, for which time is the object but just symbolically represented, technical configurations are capable of operating (as) time itself; techno-intrinsic temporality demands another kind of media philosophy of time, such as "the temporality of ergodic art" = Espen Aarseth, Aporia of Epiphany in Doom and The Speaking Clock. The Temporality of Ergodic Art, in: Marie-Laure Ryan (ed.), Cyberspace Textuality. Computer Technology and Literary Theory, Bloomington / Indianapolis 1999, 31-42; Aarseth does not consider it in accordance with the probability mathematics of Norbert Wiener; Frank Furtwängler, Human Practice. How the problem of ergodicity demands a re-animation of anthropological perspectives in game studies, in: The Aesthetics of Net Literature. Writing, Reading and Playing in Programmable Media, ed. Peter Gendolla / Jörgen Schäfer, Bielefeld (transcript) 2006. Media archaeology constitutes an attempt to account for this alternate temporality of media. The linear prediction code – developed in the context of antiaircraft defence and fire control during World War II, but used today as a probability indicator in all aspects of life – is the model here. It represents the calculations that form the basis of Wiener's time-critical research; analogy to current micro-temporal economies – such as computer games – insofar as their operativity is equally as time-critical as it is (seemingly) infinite in its combinatorics; question already raised by Leibniz in his fantasy *Apokatastasis panton*, an early version of Poincaré's return on the basis of the combinatorics of all letters in a library; *The Library of Babel* (Jorge Luis Borges)

- Heidegger's "Kehre" (turn): no historical existence (*Dasein*) could have invented the radio, but – conversely – technological media, such as the radio, determine historical ways of being (*dazusein*)

Annales Sangallenses

- where cultural techniques end and technological media begin; medieval annals not equal to syntactical word listings in Weizenbaum's KI program ELIZA; early Medieval Annals performing the discrete time sequence of a "sampled" continuous function called reality; translation from analogue perception to digital registration (technically: A/D conversion); micro-temporality in operativity of data processing (synchronization) replacing the traditional macro-time, a literal "quantization"

- cinema still adhering to a dramatic concept unfolding in time[501]; time now being organized by technology itself[502]

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501 Monika Halkort, Datenbankbasiertes Broadcasting - Neue Erzählgenres im Netz, in: do it yourself! Kunst und digitale Medien: Software - Partizipaton - Distribution, hg. v. Andreas Broeckmann / Susanne Jaschko, Berlin (transmediale.01) 2001, 155-159 (155)
502 Paul Virilio, Technik und Fragmentierung, in: Karlheinz Barck u. a. (eds.), Aisthesis. Wahrnehmung heute, Leipzig (Reclam) 1990, 71-82 (71)

- algorithms displacing classical story-board; script is not a screen-play any more (story-telling), but code lines; programmer is not interested in stories any more; rather he writes discontinuous jump adresses to Hot Spots; designing a computer game today 95 % of digital administration (setting links), just 5 % "authorship"; programming practice deconstructing "narrative" scenes into most elementary morphological units. Linearity (which in the case of film is based on the irreducable material linearity of celluloid already) has to be introduced articifially on CD-ROMs for guide-lines

Computational Archaeology (proper)

- Anthony Grafton, Bring out your dead. The past as revelation, 2001, 338 (notes to pp.193-196), note 63: "*Jacques Spon*, Recherches curieuses d'antiquite, Lyons 1683, Preface, sig. a3r: '*Archaeographia* est declaratio sive notitia antiquorum monumentorum'"; "archaeographical" representation under the auspices of digital computing techniques; René Ginouvès / Anne-Marie Guimer-Sorbets, La Constitution des Donnés en archéologie classique. Recherches et expériences en vue de la préparation de bases de donnés, Paris (Éditions du CNRS) 1978; distinguish "*descriptive 'archaeography'* " of material findings "from more *interpretative archaeology* in a narrower sense"[503]

- technological methods in archaeology - in fact from the material (digging / material excavation) to the data-processing epistemology = Maier 1977: 27; Riederer / von Rohr (eds.) 1973: Kunst unter Mikroskop und Sonde. Naturwissenschaftliche Untersuchungen an kulturhistorischen Objekten; F. R. Hodson / D. G. Kendall / P. Tautu (eds.) *Mathematics in the Archaeological and Historican Sciences* (Edinburgh / Chicago: Edinburgh University Press / Aldine Atherton, 1971; statistical methods, quantification and computer processing of data does not relieve the technically registered data from the need to be interpreted but human evaluation. Mathematics - in a circular argument reminiscent of Alan Turing's statement on "computable numbers" (1936/37) - helpful in sharpening aspects of analysis which *can* be made pure mathematical (Kendall), no certainty but reducing the level of uncertainty = front flap

- structural affinity between archaeology as material-orientated science (opposed to philology, as long as its hermeneutic method is bot being replaced by statistical analysis = Liliana I. Boneva, A new approach to a problem of chronological seriation associated with the works of Plato, in: Hodson et al. (eds.) 1971, 173-186, and computing, in a auxiliary and a methodological sense. Inbetween the material monument and the philological text record stands the inscription = Alexandra Stefan, Applications of mathematical methods to epigraphy, in: ibid., 267-275; pratice of constructing genealogical filiation of manuscript tradition in the diagramatic form of *stemma* applying a mathematical method; monks copying an ancient manuscript for tradition "made mistakes, either involuntary (carelessness) or voluntary (the desire to correct the source)" = Sorin Cristian Nita, Establishing the linkage of different variants of a Romanian chronicle, in: ibid., 401- 410 (402)

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[503] C. A. Moberg, Archaeological context and mathematical methods, in: ibid., 551-562 (533)

- archaeology one of the first sciences in the humanities department applying machine computation; J. D. Richards / N. S. Ryan, Data Processing in Archaeology (Cambridge / New York / Melbourne: Cambridge University Press, 1985); at the same time, data processing a s archaeology (for that reason the book mentioned is, for its most part, an introduction into computer programming). Media archaeology is not just a way of remembering "dead media", but rather a mathematical aesthetics; modelling, statistics and especially cluster analysis (e. g. for the distribution of objects in a grave field) one the fields where archaeology made use of data processing with electronic computers

- mathematization of archaeology: "[...] the contribution of IT and statistical techniques have a central role to play in supporting archaeological interpretation. The archaeological judgment must take precedence yet making that judgment is frequently not straightforward. Even the beneficial contribution of such 'hard' science such as radio carbon determinations of date or ground penetrating radar to archaeological interpretation, rely on operators having a close empathy with archaeological material, the context of discovery and the role of post-depositional processes. If the post-processional reaction to the scientific inductivism of the 'New archaeology' of the 1960's shows us anything it is that we need to be aware of the contexts in which we may apply our tools, be they computers or trowels" (communication Peter Rauxloh, Information Strategy Manager, Museum of London, July 2002)

Techno-culture studies and/or "cultural techniques"

- German term *Kulturtechniken* naming practices like agriculture, mathematical symbol calculation by haqnd or body movement such as rhythmic dancing as kind of automatization; Kapp's notion of 1877 "organ projections"; such practices still essentially depending on the human body or mind to be *performed* - different from truly automated processes which are *operated* by (and inbetween) machines; Bernhard Siegert, Cultural Techniques. Grids, Filters, Doors, and Other Articulations of the Real, transl. by Geoffrey Winthrop-Young, New York (Fordham University Press) 2015; "ontological reversal" whereby activities such as counting *precede* the associated concepts such as number, normally thought to come first" = Winthrop-Young, Geoffrey, Cultural Techniques: Preliminary Remarks, in: Theory, Culture and Society 30, no. 6 (2013): 3–19 (15), contrary to symbol manipulation (material *token*, Hilbert)

- door as cultural technique media-epistemologically differs from circuit switching / Thyratron vauum tube: "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" = Paul Virilio, The Overexposed City, in: Zone 1-2 (1986), 545

- Guidonian hand as the embodiment of a long-standing cultural technique = Horst Wenzel, Von der Gotteshand zum Datenhandschuh: zur Medialität des Begreifens, in: Krämer / Bredekamp (eds.), Bild—Schrift—Zahl, xxx, 25–56

- media archaeology as object-centered epistemology; "question of whether sounds are stored in the magnetic charges of a cassette tape, binary code, a music box, or indeed the muscle memory of a pianist is of central significance. Media archaeology argues that the medium is not merely a vehicle that is somehow external to music but is rather inextricably connected with it: the sounds exist only in and by virtue of the medium. [...] textual, analog, and digital forms of inscription constitute entirely different worlds" = Alexander Rehding, Introduction, in: Journal of the American Musicological Society, vol. 70 No. 1, Spring 2017, thematic issue "Discrete / Continuous: Music and Media Theory after Kittler", 221-256; http://jams.ucpress.edu/content/70/1/221

Signal analysis and dis-embodiment

- relevant time structure for understanding technical media not its historicity but the time structure of the signal event itself, in technical layers like tuning systems (resonant circuit), techniques to build and to en-act (bias) hardware, principles of parameter setting. Knowledge of media history has its legitimation when the question is how technologies are embedded in broader cultural textures. But this can only be the secondary step; the first has to be a reconstruction of the specific time structures unfolded by signal processing in technology itself, its temporal relations

- micro-tempor(e)alities; time-critical signal processing in humans and machines; either analogue (continuous) or discrete time; electronic synthesizer: "Attack" and "Decay"; notion of "transients" in signal processing; discrete time signal processing for signals defined only at discrete points in time (quantized in time, but not in magnitude), such as telegraphy (Morse code)

- media as agents of signal analysis; biological data retrieved (and transformed) by time-varying measure media (such as sonography, electrocariograms); signals defined as "time-varying or spatial-varying physical quantities". "In the context of signal processing, arbitrary binary data streams and on-off-signals are not considered as signals, but only analog and digital signals that are representations of analog physical quantities" = entry "Signal Processing", http://en.wikipedia, accessed on 25 November 2010

- media-archaeological levels: "In communication systems, signal processing may occur at OSI layer 1, the Physical Layer (modulation, equalization, multiplexing, etc) <...>, as well as at OSI layer 6, the Presentation Layer (source coding, including analog-to-digital conversion and data compression)" = en.wikipedia

- operative diagrammatics as electro-physical "embodiment" of symbolic languages; computational mathematics, implemented in the physical world, means being-in-time; Warren S. McCulloch applies term "embodiment" of logical (Boolean) algebra in neurons

- J. C. R. Licklider researching the essentials of what constitutes "hearing" in humans and animals (auditory analysis): "Is there, built into the auditory nervous system, a *mechanism* <W. E.> [...] that supplements the cochlear

frequency analysis?"[504] His very use of terms stems rather from electronic engineering, thus dis-embodying the analysis of human hearing

- Licklider, Man machine symbiosis, 1960; businessman becoming a servomechanism of his clock, and explicitely "the cyberneticists - and soon the entire world - of his computer" = Marshall McLuhan, The Playboy Interview: Marshall McLuhan, in: Playboy Magazine, März 1969 (*online* www.columbia.edu/~log2/mediablogs/McLuhanPBinterview.htm)

Implementations

- in computer science, implementation the realization of a technical specification or algorithm *as a* program (software) = http://en.wikipedia.org, entry "Implementation". When a piece of computer hardware can interpret a programming language *directly* (in a transitive way), that language is called *machine code*. A so-called *native code compiler* is one that compiles a program into machine code.

- the "instance" any *running* process, specifically an object as an instanciation of a class; the sister concept to "embodiment" from a media-archaeological point of view. the Smalltalk programming language e. g. is conventionally implemented by compilation into bytecode, which is then either interpreted or compiled by a virtual machine

Measuring "embodiment" with technological devices

- critique of neuro-scientific laboratory equipment as *dispositif*: "Neuroimaging techniques requiring the test participant to lie in a scanner, however, are inappropriate to investigating the process of music-making: the confines of the scanner make for unnatural bodily posture and limited movement; the noise in the scanner would prevent the participant from concentrating on musical-auditory events"; electroencephalography (EEG) not allowing for the musician to move freely, "as it is difficult to remove motor artifacts from EEG signals. Functional near-infrared spectroscopy (fNIRS) technology [...] using NIRScout, a portable NIRS system, imposes minimal physical constraints on the participant (when playing piano or a string instrument); nonetheless, current neuroimaging techniques require many more improvements to be reliable tools for investigating the process of music-making. [...] the question of what the dynamic processes of kinaesthetic simulation underlying the process of musical shaping towards fulfillment (and the co-shaping process taking place in music perception as well) look like can be most efficiently addressed by investigating the neurodynamic processes involved in music-making and music perception; such an approach does more justice to the temporal process of (co)shaping a

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504 J. C. R. Licklider, Auditory Frequency Analysis, in: Colin Cherry (Hg.), Information Theory. Papers read at a Symposium on 'Information Theory' held at the Royal Institution, London, September 12th to 16th 1955, London (Butterworths Scientific Publications) 1956, 253-268 (254)

piece of music than current structure- or function-oriented neuroscientific methods"[505]

- neurophenomenological vs. media-archaeological investigation of the aesthetic experience of music (Helmholtz 1863); temporal structures from neuroimaging data analyzed most efficiently when using a neuro*dynamic* approach, whereas at present structure- and function-oriented neuroscientific approaches are dominant = 168

- embodiment as (not only loose, but tight in Heider's sense) integration of the human into the (time-based) machine (Jan Claas van Treeck); the human becomes a chrono-prosthesis of the machine, analogous to Turing's insight from 1936 that, when calculating, man is in the "machine state"

- "implementation" of the symbolic (algorithms) into the real; "embodiment" extends (beyond the biological body) to what media archaeologists call "implementation" (from informatics), being essentially a (diagrammatical) question of being-in-operativity as comparable - yet disctinct - to human performativity; common denomiator: "music" and (neo-logically) "algorhythm"

Gaming with the Pin Ball machine

- "liberation" of the painterly hand by photography (Henry Fox Talbot, *Pencil of Nature*, 1844)

- just as human hand is coupled (in the cybernetic sense) to the Pin Ball game machine as known from public houses, as described in a typescript entitled "Flipper" by Friedrich Kittler from the 1960s or 70s which immediately anticipates the first generation of computer games (in the sense of Pias 2002); published in Kittler, Bagersee (2015). "Wenn der Mensch nur dort ganz Mensch ist, wo er spielt, so wird auch er, wenn sein Mitspieler Automat ist, zum Unmenschen" (Kittler ibid.); counts for the temporal realm as well; when discretely (not analog / diagramatically) calculating either in his mind of coupled to pen / quare paper, man is in (Turing-)Machine state (Lacan)

- "attack" in the keys of the electronic synthesizer; "Spiele, die ins rasche Reagieren einübten" (Kittler), since 19th century table tennis (finally resulting in "Tennis for two" game on analog computer); Wilhelm Wundt's psycho-physical laboratory established at Leipzig University (to be continued by Hugo Münsterberg in the Harvard Lab version later)

- challenge in anti-aircraft prediction in World War II from the point of view of the artillery, as confronted by Norbert Wiener - explicitly giving rise to *Cybernetics* itself (Wiener 1948, Introduction) - and by Claude Shannon in a different approach separating the physical laws of the machine (airplane) from the idiosyncratic (counter-)reactions of the human pilot.

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505 Jin Hyun Kim, Shaping and Co-Shaping Forms of Vitality in Music: Beyond Cognitivist and Emotivist Approaches to Musical Expressiveness, in: Empirical Musicology Review, Vol. 8, No. 3-4, 2013, 162-172 (167)

- human Pin Ball machine player with his hand(s) as interface to the automaton has to adopt to the tempor(e)ality of the machine; the equivalent to tactics in the temporal field is time-criticality; that moment, he turns into a cyborg, a true cybernetic organism: part of a closed circuit (German *Regelkreis*) in terms of systems theory, becoming nothing more or less than one (analog) element within an system circuitry

- intransitive automatic regulation literally: "cybernetics", replacing manual transitive control

Experimenting media-temporality

- "Thumb movies" ("Daumenkino") producing the cinematographic effect of movement by hand; hand-driven phonograph / gramophone

- Talbot on the non-human temporal efficiency of the photographic shot in *The Pencil of Nature* (referring to plate III „Articles of China"), that "the whole cabinet of a Virtuoso and collector of old China might be depicted on paper in little more time than it would take him to make a written inventory describing it in the usual way."

- *Kymograph* as self-writing nature ("Selbstschreiber"); deriving from that: phonographic cylinder which is not score notation of musical performances by the human hand but immediate acoustic recording; academic culture insisting on symbolic regime: Bela Bartok's manual transcription of Hungarian folk song recordings

- "Circular Causal and Feedback Mechanisms in Biological and Social Systems" = original title of so-called Macy-Conferences in New York, ed. by Heinz von Foerster 1949, and subsequently by v. Foerster / Mead / Teuber 1950, 1951, 1953, 1955

- temporality in a flash-like manner revealed in the "experimental event"; the micro-temporal behaviour of the media in question; what it does to (or with) the "temporal sense" of the human experimentator, and c) what are the consequences for the historiography of such experimental settings: On the one hand, they clearly belong to what we call and describe as cultural history (or "history of knowledge" in more Latourean terms), but on the other hand (from the point of view of the media themselves, that is: the media-archaeological perspective) there is something at work which is indifferent to historical change, the "time-invariant event"

Against reduction to discursive effects

- media-experimental setting as an artificial configuration based on cultural knowledge; still it is nature, since there are electro- or even quantum-physical laws at work which are not completely dependend on the respective cultural discourse; media-experimental event can not be reduced to discursive effects; like historian Reinhart Koselleck insisted - againt the relativity of historical

interpretation - on "Veto-Recht der Quellen", an eqivalent in media-technical experimentation

Applying the media-archaeological method

- in media-experimental setttings, not static ontological objects, but micro-momentary processes unrevealed (a kind of Heideggerian *aletheia*, "Lichtung" / electric lightning). The figure/ground dichotomy, so prominent since early *Gestalttheorie* (Edgar Rubin 1915, Max Wertheimer xxx) and returning in Marshall McLuhans model of "tetrads" in media-historical configurations (*The Global Village*), here transforms into a dynamic essence: "Die Gestaltpsychologie in dieser Form ist nur vor dem Hintergrund der Erkenntnisse der Elektrodynamik von Maxell, Faraday, Helmholtz und Hertz über das elektrische Feld denkbar. <...> Die Weise, wie sich potentielle Figuren innerhalb eines Grundes (Feldes) verhalten, ist dem elektrischen Feld analog."[506]

- audio-visual and computing media addressing humans at the existential essence of their sensation of being-in-time; while media historiography concentrating on the figurative phenomena, electronic media archaeology revealing the ground or rather: field

Looking *versus* listening at the monochord

- Charles Sanders Peirce on *diagrammatic reasoning*: "Similar experiments performed upon any diagram constructed to the same precept would have the same result."[507]

- reenacting procedure which Pythgoras experimented with the monochord in the 6th century B.C. today; actually reenacted is the techno-physical insight of the relation between integer numbers and harmonic musical intervals; certainly not in the same historical situation like Pythagoras, since the circumstances, even the ways of listening and the psycho-physical tuning of ears, is different. But still the monochord is a time-machine in a different sense: It lets us share, participate at the original discovery of musicolgical knowledge; in an almost Derridean sense (expressed in his *Grammatology*), the original techical experience is repeatable; experiment allows for com/munication across the temporal gap (bridging a temporal, not spatial distance like mass media do)

- Peter Heering / Falk Rieß / Christian Sichau (eds.), Im Labor der Physikgeschichte. Zur Untersuchung historischer Experimentalpraxis, Oldenburg (Bibliotheks- und Informationssytsem) 2000, esp. 9-23 (on textual

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506 Kathrin Kadelbach, Der Versuch einer Zeitfigur der Fotografie, Hausarbeit (2009) zum Seminar *Irriationen und neue Formen der Zeitwahrnehmung durch Medien* (Sommersemester 2008) am Seminar für Medienwissenschaft der Humboldt-Universität zu Berlin, 32 (unter Bezug auf ein Argument in: Richard Zakia, Perception, Evidence, Truth and Seeing, in: The Concise Focal Encyclopaedia of Photography, Elsevier (Focal Press) 2008, 239-250 (242)
507 Charles Sanders Peirce, Collected Papers, Bd. II: Elements of Logic, Cambridge, Mass. (Harvard UP) 1932, 350 <prüfen!>

vs. artifactual evidence), and 142 (on the ideosyncracies of the experimental setting ("Eigendynamik"), and *eigenzeit*

- reproducing nature with cultural means; *physis* both agency (measuring instruments, subject to physical and mathematical laws) and object of experimentation, in a co-originary way; Christian Kassung, Das Pendel. Eine Wissensgeschichte, München (Fink) 2008

Re-experiencing Baird's television

- "archaeology" of television in John Logie Baird's system; best method for *understanding media* their re-engineering and putting into function; in this case: an operative modell of Baird's *Televisor*. Nowadays in England, the Narrow Bandwidth Television Association (www.nbtv.org) since 1975 takes care of such early electromechanic, low-definition television. "The Association continues to extend its achievements, including the spanning of the Atlantic in January and February 2003 in emulation of J. L. Baird's 1928 exploit."[508] *Nota bene* the use of the term "emulation", which signifies a kind of re-enacting which is co-temporal to the original itself. There is an experimental Televisor kit offered by the Middlesex University as a "teaching resource" (www.mutr.co.uk); accompanying brochure brings out that media time is about functional equivalence, an in fact: repeatability, functional re-enactment (to take a notion developed by the historian Collingwood) in experiencing hight-tech media time is closer to the criteria of an experiment in natural sciences than to historicist idea of history: "The *televisor* you have just purchased works in exactly the same way as the original, but uses modern components such as an LED instead of a neon lamp for pucture illumination." And more specifically: What difference is between a functionally equivalent electronic component and its actual embodiment (such as the electronic vacuum tube and its functional replacement by the transistor)?

- "It is about one third of the size of the commercial televisor - but the performance is as good" = ibid. - a transformation of original to model; central a-historical criterium remains: "performance" as *gleichursprüngliches* re-enactment

Sound and vision as radio and light waves (Heinrich Hertz)

- 1879 Hermann von Helmholtz initiating a prize (Berlin Academy of Sciences) to answer the dispute which was the true theory of electricity: Weber / Neumann (no wave-like transmission, broken through an intermediary medium, but rather immediate re/action, in the tradition of Newtonean physics), or James Clerk Maxwell: Electromagnetic waves are part of an encompassing electromagnetic spectrum like light, thus subject to temporality, a limited speed.[509] Radio waves, on the very media-archaeological level (that is, before becoming part of a mass-medium called "radio") have a *sense of ending*;

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508 Quoted from the brochure accompanying the Televisor kit offered by the
    Middlesex University as "teaching resource"; see www.mutr.co.uk
509 See Wolfgang Hagen, Das Radio, Munich (Fink) 2005, 30

Wolfgang Hagen, Technische Medien und Experimente der Physik. Skizzen zu einer medialen Genealogie der Elektrizität, in: Rudolf Maresch / Niels Werber (eds.), Kommunikation, Medien, Macht, Frankfurt/M. (Suhrkamp) 1998, 133-173 (*online* www.whagen.de)

- electric sparks known since pieces of amber rubbed with textile, named after Greek *elektron* since Thales of Milet; such sparks already behaved like "radio" - but missing detector, both mentally (in humans) and technocally (no "detector" until Eduard Branly's "Coherer" since 1890, invented as a laboratory device, further developed by Oliver Lodge in 1894). Radio as such "found" but not invented in the laboratory; rather put together by entrepreneurs like Giulielmo Marconi who combined the Hertzean apparatus with Brandly's device and Popov's antenna to a functional tool for transmitting wireless Morse code); still, the experimental system "knew" it already: Douglas Kahn, Radio Was Discovered Before it Was Invented, in: Golo Föllmer / Sven Thiermann (eds.), Relating Radio. Communities, Aesthetics, Accesss. Beiträge zur Zukunft des Radios, Leipzig (Spector) 2006, 24-32. Such alreadyness as index of a non-historical media temporality which is equally original each time ("gleichursprünglich")

- media archaeology concerned not with inventions but dis-coveries

- experimenting vibrations: electro-magnetic wave propagation, that is: the media-archaeological experience of technological media, not (merely) prehistory, but alternative appraoch to what has become the mass medium called "Radio"; Heinrich Hertz' discovery that electromagnetic waves propagate by means of high-frequency excitation of an open oscillating circuit, the result of a research query. "Radio" at first not language and music broadcast but rather radio waves for wireless telegraphy, particularly radio telegraphy in marine radio after 1900. Term "radio" accordingly meant literally, in order to emphasize the specific properties of electromagnetic fields, namely the radial effect of the waves, broad-casting on the physical plane. It is therefore not enough to characterize radio simply as a device for receiving radio broadcasts, referring primarily to their content. Based on radius, that is, ray, the message is above all the medium: electromagnetic waves and high-frequency electrical signals, transmission, and sound, enunciated in latency

- electrotechnical transformation of speech into signals, of signals into waves, into recording and radiation

- for Marconi, coherer as thunderstorm detector, combined it with the idea of a transmitting antenna. Marconi practicing wireless telegraphy; in 1901, communication bridged the Atlantic using electromagnetic waves for the transport of coded signals; "wireless" not always been synonymous with radio; patent registered in1904 by Marconi's engineer John Ambrose Fleming, further developed an effect detected by Edison in light bulbs, by which electricity can flow from filaments to an additional enclosed electrode, even if no direct contact exists. In his patent manuscript of 1884, *A Manifestation of the Edison Lamp*, Edison explicitly describing electricity flowing through the vacuum "without wires", literally wireless; radio inside the evacuated, etherless tube itself

- spark gap transmitters generating pulse-shaped waves; why Heinrich Hertz did not already consider radio as acoustic content in his experiments; early radio was closer to Morse Code than to what we know as radio today, or, to put it differently: it was literally digital before it became, through speech and music modulation, an analog medium. The digital managed its reentry through pulse code modulation—with which radio in fact finds its way back to its original potential as broadcast medium; 1906, when the International Wireless Conference in Berlin regulated the handling of wireless communication; only with the introduction of tube technology that the human voice or music lastingly replaced Morse Code. Radio as function of a technological escalation: the vacuum tube; opposite of such electronics based on low-voltage current the Telefunken high-frequency machine transmitter of 1912 with a frequency of 10 kHz, which could be transformed up to 170 kHz, making telephony attempts from Königs Wusterhausen to Vienna possible in 1913; mechanical limits of such wave generation forced the paradigm change to the field of nearly inertialess electronics, the realm of the modulatable electron stream in a vacuum / electron tube transmitter

- invention of the electronic vacuum tube by Robert von Lieben in Vienna and Lee de Forest in the USA independently in 1906 as the decisive technohistrical mark of co-originality; 2006 therefore "one century of radio"? even antique radio, when successfully transducing signals, never in a historical state, rather in a present state; technological medium does not conform to the historicism of linear epochal concepts but infrastructual *durée* as *epoché*; in actuality, it undermines this logic and sets a different temporal economy

- an original recording resonating today from an old tube radio, provided it is still run on 220 volts, hardly making "history" audible; tube-based radio practicing compressed time as respects sensory perception, as long as this is not overlaid with "historical meaning" which cognitively does not correspond to the actual media workings of radio but rather to the logic of inscribed historiography

Technological addressing of human being (in time)

- experimental means of investigating eventality, temporality, duration, and becoming; primary level of temporality in a flash-like manner revealed in the "experimental event"; the micro-temporal behaviour of the technological media in question (that is: "under experiment"); the second one is what it does to (or with) the "temporal sense" of the human experimentator; AV media address us at the existential essence of our sensation of being which is the temporal sense

- AV media addressing human senses at the existential sensation of being temporal phenomenology. They re-generate temporal experience, thus adressing the human on the sensory (aisthetical, physiological) level as radically present, while our cognition puts it into a "historical" context: a dissonance taking place, gap opens

The genealogy of mass media from measuring (experimental) media

- "No analysis of natural science, whether it be physics of biology, is complete unless we possess a proper analysis of its appropriate time-concept" = Norbert Wiener, Time, Communication, and the Nervous System, in: Annals of the New York Academy of Sciences, Bd. 50, 1948/50, 197-219 (197)

- "In experimental settings nature tells us something which does not exist somewhere in the natural world" (Haley)

- electro-physical measuring / recording of cultural articulation (digitally by "sampling") subjecting the signal event to experimentation, thus enabling a non-hemeneutic analysis of cultural articulation on the sub-philological, even sub-alphabetic level

- media-archaelogical context; what later became mass-media like the phonograph, kinematography, electronic television first develped for experimental research, for analytic, not projective purposes (even the genuinely theory-born computer). Any listening to music on records or to radio programs is essentially experimental, a kind of reverse experimentation. The well-known television tube has developed out of a mesuring device, Ferdinand Braun's electronic oscilloscope, like the Edison phonograph has been preceeded by Léon Scott's "Phonautograph" to register the frequencies of the human voice for analytic purposes. Tuning (analog) radio is experimenting with radio waves and their electromagnetic resonances. The public use of "synthetic" mass media is *reverse experimentation* of analytic media (a term alluding to the media-archaeological practice of "reverse engineering")

The time-critical dimension as a genuine form of media experimentation

- both in humans and machines, micro-temporal events crucial for the whole process to succeed at all - as an epistemological object of knowledge not only relatively new in occidental culture but one which came into focus only my hight-precision time-measuring media itself; time-critical dimension is a genuine form of active media knowledge and archaeology. Only with such instruments as Christiaan Huyghens' pendulum clock, leading to the introduction of minutes and even seconds on the clock skale, and more specific with elecro-mechanic measuring devices as developed by Hermann von Helmholtz to cope with the speed of communication within nerves, and finally with electronics, the micro-temporal delays (Delta-t) which happen within brain functions could be analyzed; Adrian's electro-physiology with its technological *a priori*, the thermionic tube

Experimental time *versus* history of knowledge

- technological eventuality as time signal vs. history; experimental diagram vs. historiography which is the act of symbol registering, both by measuring media or humans, in the laboratory

- Edgar Wind, Das Experiment und die Metaphysik [habilitation thesis 1929], Frankfurt/M. (Suhrkamp) 2001, chap. "Theorie des Experiments", 70 ff.

- experimental settings, being unnatural / artificial, belonging to cultural knowledge; on the other hand, from the point of view of the media themselves, that is: the media-archaeological perspective, something at work which is indifferent to historical change, the "time-invariant event"

Media-eventuality

- relational definition of *object* and *event*: "Eine mögliche graphische Metapher für die Komplementarität von 'Ereignis' und 'Objekt' ist ein rechtwinkliges Gitter, das von beiden gebildet wird" = Heinz von Foerster, Bemerkungen zu einer Epistemologie des Lebendigen, in: idem, Sicht und Einsicht. Versuche zu einer operativen Erkenntnistheorie, authorized version in German by Wolfram K. Köck, Braunschweig / Wiesbaden (Vieweg) 1985, 81-93 (87); AO: Notes on an Epistemology for Living Things, in: Biological Computer Laboratory Report No. 9.3, University of Illinois, Urbana 1972; diagrammatic laboratory, where objects and relations meet

- in software engineering, so-called "event" meant to govern a momentary use of the computer program in non-linear ways (often user-orientation at interfaces); the "interrupt", f. e., makes the mechanism wait for signal input from outside, and in modelling an arbitrary input leads to related events in the simulation.

- "time" and "event" concepts of event-orientated programming; in philosophical phenomenology, "event" a singular and instant act which can not be subsumed under general terms but is still constitutively at work for being, acting, knowing. In Martin Heidegger's late philosophical work, the fundamental notions of being (Sein) and time (Zeit) converge in the event (Ereignis) = Martin Heidegger, Beiträge zur Philosophie (Vom Ereignis) [Gesamtausgabe III. Abt. Unveröffentliche Abhandlungen Vorträge - Gedachtes, vol. 65], Frankfurt/M. (Klostermann), 3rd edition 2003

- analytic ontology (Alfred North Whitehead) focusing on the processual "event"; processual ontology close to the essence of media technologies itself (since only when being in operation a medium is in its medium state); media archaeology (different from the apparant archaeological metaphor) not uncovering artefacts but events

- use of the term "operational"; employment of scientists in WKII (esp. British) operational research with the impact of mathematical-statistical methods, OR opens a temporal horizon ("future in the past", the anticipatory prediction of enemy aircraft behaviour), a truly experimental *eventuality*

Beyond experimentation

- in historical research, past events can not be experimentally re-enacted (except in experimental archaeology); argument of historians usually applied to differentiate their hermeneutic discipline from the natural sciences; media-

archaeological experimentation (as opposed to historicism) providing access to the invariants of knowledge in time

- "How should an experimenter proceed when faced with a Black Box?" = Wilhelm Ross Ashby, *An Introduction to Cybernetics*, London 1956, 87. Cybernetic replaces experimentation with modelling, culminating in simulation, f. e. of nuclear reactions, by electronic analog computers first (and stored-program digital computing later)

- "referential" writing (as transitive *mimesis*) itself becoming operative: In science, "mathematical symbols <...> have a particularity: they reveal structures"[510], in fact: they become media-archaeological operators themselves (*poiesis*).

- diagrammatical in the sense of Charles Sanders Peirce's "diagrammatic reasoning": "Mathematics is just the detection and investigation of structures of thinking which lie hidden in the mathematical symbols."[511]

- distinction between referential and operative writing correlating with the distinction between semiotic and signal-processing systems

Artistic experimentation as metaphor?

- artist group *Ohio* producing movies from experimental settings, such as the behaviour of a model rocket in a wind tunnel = video edition *Ohio* # 13 (2004) = www.ohiomagazine.de. "Nicht das Ge- oder Misslingen dieser Experimente ist für die Künstlergruppe Ohio von Interesse, sondern die Bilder sind es, die von ihnen gemacht worden sind."[512] Diagrammatically, media recording has a transitive, techno-aisthetic relation to the experimental event, being a form of kinematographic analysis of the kinetic event, while its media-artistic re-play has an intransitive, esthetical value; film essayist Harun Farocki made such cinematographic reflection another form of media theory itself: *Auge / Maschine*

- Jan-Peter Sonntag, in his "Son:arc project", re-staging historical experiments on electricity as "research art"; a similar "experimentation as *art* event" takes place in his investigation of the Polar Light (Performance at the Alfred Wegner Institut Bremerhaven, October 30, 2009), tracing the so-called "Warden Sprites", kind of electro-magnetic Tsunami caused by solar turbulences, seen in September 1859 as emantation of "Nordlichter" around the globe; nineteenth century electric telegraphy disturbed by such "natural radio" even before radio as cultural broadcasting had been invented - kind of retro-media archaeology.

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510 Max Born, Symbol and Reality, in: Objectivité et réalité dans les différentes sciences, Archives de l'Institut International des Sciences Théoretiques, Brüssel 1966, 151f. See Charles Alunni, Gustave Juvet (1896-1936). Un Pionnier Oublié des Études Cliffordiennes, in: Advances in Applied Clifford Algebras, Basel (Birkhäuser) 2009, 14-38 (26)
511 Born ibid.
512 Ohio (Uschi Huber / Jörg Paul Janka), in: Zeitschrift für Medienwissenschaft 1/2009, 104-113 (104)

SPRITES are ultra-short appearances of light between the troposphere and the ionosphere (the reflecting medium for short wave radio) which cause echoes in (natural) ELF waves (Etrem Low Frequency). Such "events" are used by Jan-Peter Sonntag to modulate fluorescent tubes fill with lightning gas (causing "TESLA-light") and to cause perceivable sound out of these ultra- and infra-sonic waves. "Sferics" is the technical term for atmospheric long-wave radio signals caused by thunderstorms et al.

- beam forming: "acoustic camera", based on a microphone array, makes acoustic events in space visible in ways which locate the source of sound. Thereby one sees what is heard synaesthetically, based on time itself as a channel: signal runtime differences (Delta-t). What looks like a spatial operation, takes place in the time domain and thus turns space into an event. The experience of space by temporalization is known in its crudest form by binaural hearing in humans, and as echo location. But such mechanical evidence in Newtonean space failes within the electromagnetic field.[513] The Siemens Studio for Electronic Music, as preserved and displayed in the Deutsches Museum at Munich, demonstrates how the very existence of electro-acoustic as art form is a direct function of measuring media. Only electronic devices develop an "ear" for the EM

Media-archaeological experimentation

- chrono-photographical experimental setting of Eadweard Muybridge to answer the question if horses in the course of galopping at one moment lift all four legs above ground (too fast to be noticed by human eyes, such as the painterly gaze); laboratory setting constructed by Ernst Mach and xxx 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

- installation *Blow up TV*; media artist Angela Bulloch using a key visual, a sequence from Michelangelo Antonioni´s film *Blow Up* (1966): the protagonist, a photographer, hiding behind a tree taking photos to discover a murder; but in trying to identify the spot, the closer the camera looks, the less is the apparent murder an evidence [siehe Karl Krauss? "Je näher man ein Wort anschaut, desto ferner schaut es zurück"]. The artist extends this process of identification by yet another magnification, enlarging the digital scan of this scene in great blocks of its single pixels; 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[514] - a

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513 See Johannes Gfeller, Der Referenzgerätepool von *AktiveArchive* an der
    Hochschule der Künste Bern, in: Schubiger (ed.) 2009, 212-221 (215)
514 Such is the installation *BLOW_UP T.V.* of Angela Bulloch in the gallery
    Schipper & Krome, Berlin, September to November 2000

desillusion of the image betrayal of the human eye, reavealing the scanner-gaze of the computer which is "looking" at a different kind of evidence, not looking for letters any more; pixel modules - which also point at the fact that digital images are hyper-indexically composed by pure information, as opposed to the referential image like the classical photography which still suggest a pre-discursive real - developed by Angela Bulloch and Holger Friese, indicating that multi-media archaeology requires high-technical skills

- pixel as smallest conceivable picture element, which makes sense in a semantic 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 look, the more distant the "image" becomes

- in addition to spatial distance, 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.

- media experimentation basically experimentation of temporal figures

- Swiss video artist Jean Otth manipulating the line deflection electronics of a TV set in order to create a simple horizontal line on the screen which is pulsed by the intented, but not realized line transfer rhythm. He called this 1974 piece *Exercice IV de l'abécédaire télévisuel*; reconstruction of this video installation in Kunstmuseum Luzern (2008), catalogue: Irene Schubiger (ed.), Schweizer Videokunst der 1970er und 1980er Jahre. Eine Rekonstruktion, Zürich (ringier Verlag) 2009, 92. A measuring test of the signal flow on the oszillocope proves that this has been a conscious manipulation and not just a defect of the apparatus.[515]

- TESLA Televizor 4002A in MAF in two variations: its "consumer" appearence and its "analytic" presence (bare chassis), reflect upon the difference between media as interface and as technology; close analysis of 4002A clearly reveals the continuity of that TV set to pre-Second World War developments of electronic television, thus bridging the historical/political discontinuity by media-technological continuity, starting point for a theory of media time

Transatlantic alliance: Media Archaeological Lab / MAF

- media archaeological analysis gaining insights from the technological devices in operation; disassembling and re-assembling tools; as well *symbolically* opening the "black box" to get insight into what media do; investigate program close to the machine like Assembly; Signal Laboratory focusing on operational media analysis; computer platforms in working condition; „hands on" approach is imperative; historicity vs. functional equivalence in retro-computing

- Media Archaeological Lab (University of Bolder, Colorado), concentrating on

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

electronic literature, while MAF investigates the "literature" (programming and hardware circuits) of early computing (and other media); conceptual exchange between literature, digitality and electronics

- Lynn Hershman-Leeson's film *Conceiving Ada*; by code the present time in touch with the past - a media-archaeological rather than media-historical short-circuiting of (media) times; reminds that media archaeology is not just about the digging metaphor, but about mathematical clearness as well

- Media Artefact Pool made up of "antique" / techno-archaic artefacts that are (anachronistically in the media-archaeologica understanding of technological temporality) highly relevant to our contemporary media culture – ranging from an electron-ray indicator tube to a temperature sensor used as a periphery device on an early Commodore 64 computer; oriented around the concept of an operational Media Theatre; objects not presented as examples of design; instead, focus primarily on the objects' function and internal aspects / functionality

The non-human meaning of "media archaeology"

- archaeology not reduced to search for a beginning, analysing the enunciative function that operates within technology, the general "archive" system to which it belongs - which is implemented algorithms today

- moments when media themselves, not exclusively humans any more, become "archeologists" of epistemic objects (imaged-based image retrieval); beyond Marshall McLuhan, media are not just extensions of men any more, but have become autonomous, creating a chrono-poetics of their own

- by necessity, any archaeology suspended from making cultural sense prematurely. Being confronted with the absence of humans in sites of material culture and with non-human artefacts, archaeology has been "posthumanistic" always already.

- what it says about "human" communication if its effect can be achieved by intermediary transsubstantiation into binary data processing, storage, compression and transmission, like in smart phones? Human cognition capable of dealing with mobile tele-presence without suffering from a choque of physical absence. Even human communication itself is signal transduction first of all (acoustically), and already coded (articulated language / alphabetic writing). When the "most human" in cybernetic and communication engineering analysis turns out to be the most symbolic, the with*in-human* is revealed (*aletheia*). When Hermann Helmholtz published his seminal *Lehre von den Tonempfindungen* in 1863, the subtitle declares a kind of sonic *arché*: the "physiologische Grundlage", as almost literal "foundation" for the theory of music

- media archaeology referring to nonhuman procedures by not concentrating on media on the level of their surface effect on humans (phenomenal interfaces), but rather uncovers the hidden agenda of technomathematical artefacts, their artefactuality. Nicole Starosielski's research on the undersea cables of

international communication is "reminding readers about the materiality of the virtual. Circulation takes place not in the ethereal clouds, she writes, but in cables underwater"[516].

- in order to become aware of such infrastructures, taking the point of view of the machines themselves, which is not anthropomorphizing technology, but rather mechanomorphic itself; procedures of signal measuring, A/D conversion, and data processing kind of "inhuman hermeneutics", knows things which are hidden from human sensual perception. At the same time, technologies as materialized knowledge are product of theoretical reasoning and cultural engineering , therefore not alien to human perception but in alliance with procedures within the human itself, like the language machine and cognitive calculation. Instead of defining technologies as "nonhuman" agencies (Latour), discover signal events within the human machinery itself such as voice-as-frequencies below logocentrism (the cybernetic "communication" assumption). Shannon's "Mathematical Theory of Communication" temporarily relieves "information" from all semantic references; a transmitter of radio waves "communicates" with the radio receiver; computers communicate within the in-between *alias* Internet

- media as physical channels of communication and as technical artefacts operated by symbolic codes and streaming data; archeological gaze analytic rather than discursive, infra-structural rather than sociological, archaeographical rather than historiographical

- implicit technosonicity (analog signal transduction) and musicality / digital "algo/rhythm" (Miyazaki) of technological events. While sharing with classical archaeologists attention of the material artefact ("hardware"), the essence of media archaeology comprises the *operative*, processual mode of technologies, since any technical artefacts is in a *media* state only when actually transducing signals or processing data. Otherwise, it is just a piece of material furniture. In terms of media-archaological description, this leads to replacing verbal techno-symbolical *ekphrasis* by directly showing the artefacts in operative motion, that is: by "movies"; see https://www.youtube.com/watch?v=V37S95AE3Pc

- media-theatrical scence the confrontation between the "operative" machine and the "performative" human, investigating the delicate human / apparative coupling of such things called media

Displacing narrative media history: diagrammatic media archaeography

- media archaeology concerned with media not only on their structural but as well on their *operative* level, thus becoming "post-structural" or "diagrammatic" defined as a "'geste symbolique', une abstraction qui en même temps contient des aspects essentiels du geste et des directions vers la pensée symbolique. Ce lien conceptuel est exactement ce qui est au centre de la

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516 Niko Higgins, in: Twentieth-Century Music 14/1 (2017), 153–158: 157, referring to Nicole Starosielski, The Undersea Network (Durham, NC (Duke University Press) 2015

pensée dite 'diagrammatique' <...> une <...> formulation du rôle intermédiaire du diagramme entre le geste et le symbole"[517]; generatives Archiv: "Le diagramme n'est pas inséré dans une machine, dans un système des règles, il est un générateur" = Mazzola ibid., 154; post-structural vector of media archaeology (or of a diagrammatic media theory) beyond semiotics and closer to signal analysis, with a signal being the physical representation of a message respectively information; any media event "Zeitfunktionen der Signale"[518]

- operative diagrammatics not restricted to the electric circuitry of analog media, aiming at understanding how digital media put mathematical algorithms into operation, how it technically transforms algebraic formulas into commands, and how engineering routes and automates functions that humans have mistaken as exculisvely human before

- Media Archaeology not aiming to relegate Media Studies as part of the Sciences Faculty (mathematics, engineering) exclusively; as well rooted in the philosophical faculty ("Humanities") since its ultimate target of technological knowledge is to make explicit the epistemological insights which are implicit in the technical commands, executions and operations

- temporal aesthetics of Media Archaeology a-historical; it is not about contextual information about past media, but creating situations where getting into contact with media in its radical operability and temporality; studying the papers of the Turing estate in the archives of King's College, Cambridge, not resulting in a historian's contextualization of past discourses but in sharing the mathematical situation in its non-historical presentness - which applies to the turingmachine (*alias* computer) itself; its operational functions are the media archaeological momentum which is, essentially, un-historical

- "radical" media-archaeological approach to media temporality mathematical by nature; Fourier-Analysis transforming the time axis of wave form signals such as acoustic vibrations or electronic image scan lines into the frequency domain: "Eine Archäologie dieser Frequenzen wäre in dem Moment gewährleistet, in dem "es gelingt, einen Zeitbereich ganz ohne Metaphysik und Geschichtsphilosophie in den Frequenzbereich zu transformieren"[519] - a geometrization which, according to Bernhard Vief, has been prefigured by the spatialization of oral speech as vocal alphabetic notation already

- techno-epistemological media archaeology; operativity of circuit diagrams which transduce electric signals

- technical devices becoming "media" only in instanciation; such operativity embodies a different temporal logic compared to "historical time"

517 Guerino Mazzola, La Vérite du Beau dans la Musique, Paris (Delatour France) 2007, 153, unter Bezug auf Jean Cavaillès, Gilles Deleuze, Gilles Châtelet und Charles Alunni
518 Karl Küpfmüller, Die Systemtheorie der elektrischen Nachrichtenübertragung, Stuttgart (Hirzel) 1974, 393
519 Friedrich Kittler, Draculas Vermächtnis. Technische Schriften, Leipzig 1993, 200

- cybernetic epistemology implied by the "digital retro-action" idea of a feedback-loop between analogous past and digital present addresses the "archival", discrete paradigm of past-as-databank(s) as opposed to analogue, narrative historiography in linking past to the present

- digital retro-action in a techno-active sense by the digitization of analogue source material from the audio-visual (broadcast media) archives and in the present: translating analogous world into a digital matrix; referring to the past, digitization of records from the past affects paper with new options of accessablity by intelligent search algorithms, as well images and sound; micro-temporality in the operativity of data processing; computers "retro-actively" transforming narrative aesthetics into non-discursive, algorithmic configuration of events

Operational media archaeology

- January 2014, by chance discovery of a waste TV, half covered by years of dust, grass and leaves: an old tube-based television set in the woods north of Berlin; careful "excavation" while reflecting in parallel about the multiple tempor(e)alities of decay / entropy which are involved in such a device - from the almost indestructable vacuum tubes down to the electric circuits which partly dissolve into something like abstract geometry; re-enacting TV set from reading its electronic circuitry as operative media diagrammatics

- storage as crystallization of temporal objects resp. recycling; endurance of storage becoming increasingly more short-term. ROM (long-term read-only memory) challenged by RAM, by random access. Final storage transforms into interim signal buffering; still, storage does not disappear; "cloud computing" emblematic of the other kind of distancing that takes place when a range of storage is outsourced and increasingly calculation is externally performed ("apps"); proprietary servers with implications for data retrieval (and reuse). Such data whether from the fleeting messaging patterns of mobile cultures or data saved on external servers retrievable in computer forensics applied now to digital cultural heritage practices; Matthew G. Kirschenbaum, Ovenden, Richard; Redwine, Gabriela (2010) Digital Forensics and Born-Digital Content in Cultural Heritage Collections Council on Library and Information Resources (CLIR) publication 149, http://www.clir.org Washington; question of who legally has access raises a different set of questions not touched upon by the more technologically focused approache

- in the technosonicistic sense, "music" modelling media time; the sonic and the rhythmic as exemplary cases in understanding of algorithmic media: how are instructions executed, how the executive operationality of data takes precedence to interpretation or semantics; logic of database replacing that of the narrative in digital media = Lev Manovich, The Language of New Media (Cambridge, MA: The MIT Press, 2001), appl a similar idea from the point of view of temporality. Referring to Vilém Flusser, model of historical time was deeply intertwined with alphabetic writing which reduced the multidimensionality of architecture and images to linear, sequential lines

- television a specific regime of the image that is not static but continuously regenerated in cycles of scanning of the cathode tube ray – line by line, which implies a different linearity to that of the narrative. Digital networks incorporate the temporality of "pings" of the ICMP protocol: echo request, echo reply are the basic communication rhythms that sustain the transfer of information over the net. (cf Pias 2011). This brand of media studies starts from the signal as the basic unit for analysis – and as Wendy Chun has noted, "signal" affords itself both towards "physical events and symbolic values" = Wendy Hui Kyong Chun, Programmed Visions. Software and Memory (Cambridge, MA: The MIT Press, 2011): 156; signal processing capacities of technological devices dependent / aimed at / communicate with sense-specific human perception physiology; online streaming, especially with slightly slower Internet connection that halts at times to load the content; this reliance on the signal as a time based process in earlier mass media; technological signal processes addressed / oriented at human perception; the signal-to-noise ratio is governed by complex diagrams familiar to engineers and mathematicians: the statistics inherent in transmission, or the specific colour worlds this has related to

- for media archeology, message of television is the signal: no semantics; in electronic television (video), color blue has a veto in chroma key resolution; same goes for the blue screen, and for manipulations of resolution and color filters

- technologies of *aisthesis*; Claude Shannon's engineering perspective on the primacy of channels and signals that temporally processed in channels as grounding (McLuhan) on which data, information and hence cultural forms are being sustained and distributed in technical media culture; mathematical codes and in their algorithmic execution, processes defined by patterns of signals unfolding in time; *dynamic ontology*: frequencies instead of beings, quantities instead of qualities and functions instead of attributes, to paraphrase Bernhard Siegert (referring to Max Bense) = "Cacography or Communication? Cultural Techniques in German Media Studies", 40: "Like physics, aesthetics is a science whose primary object is signals, the physical materiality of signs."

- technological media understood from the viewpoint of its channel capactiy which counts with time (bits/sec.). It is less about the objects of/in those channels than about the operations which introduce the patterns, pulsations and intervals through which information becomes a reality of the channels before becoming a reality for the phenomenological viewers/listeners/readers of media

- a techological medium defined as the physical passage which mediates something codified, and gets decodified at the other end; emphasis on the primacy of the channel for the tool box of the media theorist: the blunt existence of a channel as a physical reality where media starts, literally "metaphorical"

- underlying processes of signal processing, operating, executing, and synchronization form media microtemporality and time-criticality as the road for media archaeology

- all software referring back to operating systems; further back (as its condition of possibility / *apriori*) to the BIOS (basic input/output system), and so forth – tracking a "kind of descent from software to hardware, from higher to lower levels of observation" = Friedrich Kittler, "There is no Software" Ctheory-journal, 10/18/1995, http://www.ctheory.net; at the end, nothing but voltage differences, techno-linguistically

Operative diagrammatics

- media archaeology concerned with media on their structural and on their machine level (Foucault's *l'archive*); operative diagrammatics understands media as materiality-in-action; mathematics time-critically and micro-temporally incorporated into the machines

- emphasis on "operative diagrammatics"; difference between the operative (machine) and the performative (human) processes (argument Jan Claas van Treeck); machine learners can be machines as well as humans; notion of "operational archeology" = Adrian MacKenzie, Machine Learners. Archaeology of a data practice, Cambridge, MA (M. I. T. Press) 2017: 212, correlates with definition that technologies are in a "media" state only when "in being", that is: signal processing

- diagrams not simply forms of two-dimensional visualization of logical reasoning but symbolical machines themselves - though depending upon the human mind as "interpretant" (Charles S. Peirce) to operate them in the one-dimensional time domain; human interpretant is replaced by algorithms in technical computing[520] as expressed in the "impulse diagram" of clocking and computational cycling units, analysable by the "Logic analysator"; linguistic proposition becoming machine

- programming the computer, in its media-archaeological "epoque" (meant chronologically and functionally time-invariant at the same time) closer to the idiosyncacies of the hardware than to the logics of the reasoning mind; Assembly - different from "high level" programming languages - remains close to the machine, culminating in the single key to operate one bit

The cybernetic *a priori*

- "actualizing cybernetic reasoning"; case "perceptron", as pointed out in MacKenzie 2017 on *machine learners*; contemporary models re-inventing what the heroic age of cybernetics has developed; difference between then and now: computing power now ripe to actually perform analytic / simulation tasks in realtime

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520 See Frieder Nake, Das algorithmische Zeichen und die Maschine, in: Hansjürgen Paul / Erich Latniak (ed.), Perspektiven der Gestaltung von Arbeit und Technik. Festschrift für Peter Brödner, München / Mering (Rainer Hampp) 2004, 203-223

- former "Institut für Kybernetik" (Berlin, Paderborn); Helmar Frank's "cybernetic pedagogics" not only concerned with learning (by) machines but actually developing algorithms for so-called "teaching machines"; suspense of "humanistic" *a priori*

- "functionalist" premise: mental states "analogous to computational states characterized at the level of software rather than at that of whatever hardware is 'realizing' them"; mental states are multiply realizable: "need not even be organic, but could consist in electronic states of robots" = http://www.scholarpedia.org/article/Teleofunctionalism, accessed 5 April, 2018

Symbolical notation as (re-)construction of a machine: From YUGO back to Babbage

- construction "manual" (German *Handbuch*) for enacting a machine presence, while at the same time being a diagram of operative media epistemology as applied object-oriented media ontology in the sense of Ian Bogost's conceptual "carpentry"

- YUGO / Zastava. Owners Workshop Manual, Somerset (Haynes Publishing Group), 2nd ed. 1990; British manual not only readable as a text but goes down to the minutest detail - a real paper machine; allows to deconstruct and to reconstruct a Yugo from scratch (esp. my favourite: the 45 A series). The visual algorithm of the manual is convincing: "The tasks are described and photographed in a step-by-step sequence so that even a novice can do the work" - which is chronophotography in the best pre-cinematographic tradition of Marey and Muybridge" (p. 5). And the cover has a jacket comment on the series: "Every Manual based on a complete Stripdown and rebuild". To know how to take apart (to dis-assemble) is to "analyze" a machine - be it a car, or a computer.

- Babbage's "mechanical notation" in order to avoid the time- and cost-consuming task of actually building a designed machine by handicraft; hand becomes a symbol-drawer instead of ("hands on") "hand-writing"

- Babbage inspired to design his Difference Engine to avoid the errors which take place in hand writing and copies of printed tables of logarithms (Prony)

- Martin Campbell-Kelly (ed.), The works of Charles Babbage vol. 3: The Analytical Engine and Mechanical Notatiton, London (Pickering) 1989; Charles Babbage, Laws of Mechanical Notation, http://history-computer.com/Library/CharlesBabbage:LawsOfMechanicalNotation.pdf

- Reuleaux' symbolical notation accentuates the machinic modules; Babbage accentuates temporal flow; Berz 2001: 181; "mechanical notation" allows to reproduce the procedural behaviour of the designed machine, expressed in his so-called Timing Diagram (cycling units), and Flow Diagram; Doron Swade, Automatic Computation. Charles Babbage and Computational method, in: The Rutherford Journal = http://www.rutherfordjournal.org/article030106.html

- flow chart in computer programming introducing a symbolic temporal order into the machine regime; human sketch here operates on the machine symbolically, not materially

- technology-in-time; Babbage's Analytical Machine not realized in 19th century due to mechanical, financial and epistemological restrictions; on the other hand, his mechanical notation re-enactable today without loss (due to "historical gap" inbeween). No media historicism - a double bind of media history and media archaeology; on logic branching with Babbage: Andrew Ferguson, A History of Computer Programming Language = http://cs.brown.edu/~adf/programming_languages.html

The "post-computational" has been the pre-computational: analog computing

- "analog computer" not simply mimicking the physical behaviour of the real world; analogy from a common mathematical analysis of both real physics and the physics of the analog computer: the simulation is based on the mathematical equivalence of analog electronics to dynamic beings in the world; epistemology of electrical analogies (Charles Care)

- contemporary media culture taking for granted "the computer" almost automatically identified with digital computing; analog computer as apparatus may have been a dead end in the history of calculating technologies. But taken as a method, analog mathematical modelling and continuity (which is the core of analog computing) remains a radical alternative to algorithmic computation.

- Simondon conceptualizing evolution of *analog* technical devices (techno-logical individuations); for computational machines, back to Plato; analog (and therefore as well future quantum-)computing make a decisive multi-valued difference

- "post-computational" not (only) quantum computing and hypercomputation (Nückel) but a re-turn (recursion) of analog computing; philosophy rather not adequate for analog signal transducing technologies (electro-engineering); different with techno-mathematics; two deeply philosophically routed disciplines, mathematical reasoning and philosophy of technology, here merges.

- experimentation by computing usually associated with the digital computer, where the mathematical algorithm is a model of the physical event to be simulated. On the contrary, though, simulation by analog computers performs mathematical simulation by (electro-)physical means itself.

- simulation when the material object not even yet exists, such as the simulation of a nuclear reactor by analog computing

- analog computing: material elements which embody certain mathematical structures like integration and multiplication coupled according to a model analogous to the simulated object; analog machinery not a metaphysical, instransitive abstraction from the world (a "language"), but part of physics itself

- physically real, mostly unaccessible world to what can be perceived by human (measuring) senses, as defined by Max Planck; technology man-made, thus: culturally variable

- analog computing: mathematics becoming experimentation itself; message of analoge computing: doing mathematics in the engineering way (different from Claude Shannon's mathematization of engineering itself)

- media-archaeology accentuating the man / machine difference in interface design; still, logic of computing is not alien to human intuition, but rather discovers the human as mathematical machine itself (with Turing)

- celluloid- and frame-based cinematographical apparatus (mis-)reveals man as / like a symbolically programmable Turing machine / tape; the symbolical order (articulated language, cultural codes) is inplemented into the bodily real, resulting in infinitesimally variable idiosyncasies (apart from genetic code)

- computational knowledge; Leonardo Torres y Quevedo, designer of general-purpose automata (especially algebraic equation solvers), once adressed as a great mathematician, responded: "Because I invented an algebraic machine? No, that is not so; the machine knows much more mathematics than I" = quoted here after: A Computer Perspective. Background to the Computer Age, catalogue (by The office of Charles & Ray Eames) 1973 to the exhibition at the IBM Exhibit Center in New York, New Edition Cambridge, Mass. / London (Harvard University Press) 1990, 68

- in analog computing interface differing from numerical computing (until the graphical user interface turned the digital computer itself into a quasi-analog machine - on the surface)

- analogization not a construction of cultural knowledge, but an implicit knowledge from within nature itself; scientists amazed[521] by the analogous behaviour of a swinging pendulum (a mass, suspended at a leaver) and a "Schwingkreis", an electronic short-circuiting of induction (coil) and capacity (condensors); Fig. 1.1 and fig. 1.2 in: Giloi / Herschel o.J.: 12; syllogistic "medium term" of both operations, mechanical and electrical, is a mathematical differential equation: Fig. 1.1, ibid., 11

- "One of the most powerful applications of analog computers is simulation in which physical properties, not easily varied, are represented by voltages which are easily varied. Thus the "knee action" of an automobile front wheel suspension can be simulated on an analog computer in which the weight of the automobile, the constant of the spring, the damping of the shock absorber, the nature of the road surface, the tire pressure and other conditions can be represented by voltages. In practice these factors cannot be readily changed, but on the computer any one or all of these may be varied at will and the results observed as the changes are made. Analog computers are especially useful in solving dynamic problems in which the motion can be expressed in the form of a differential equation" = Operational Manual for the Heath Educational Analog Computer Model EC-1, 3

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521 E. g. Heinrich Barkhausen, Schwingungslehre, Vorwort, xxx

- simulation as performing experiments on a *model* in order to gain insights into the physically real, modelled system; today in most cases this modelling is computer simulation

- philosophy of software tools like *Simulink* (a derivate of the radically matrix-based mathematical tool *Matlab*, a commercial product of *The MathWorks*) differing from previous generations of simulation software, in that it is time-based simulation, and *Stateflow* which is event-oriented simulation; such software is based on signal processing itself, thus respecting the micro-temporalities of signal behaviour itself. Signals are temporal events, defined as "the variation through time of any significant physical quantity occuring in a useful device or system <...> a time-varying quantity"[522]. Whereas an emulation re-enacts the functions of an object, simulation rehearses its temporal qualities (*Eigenzeit*) as well

- different from purely material (archaeological) relics from the cultural past which are subject to physical erasure and entropy, symbolically encoded information - which is the essence of digital computers and has been the cultural technique of preserving musical information despite the evanescence of acoustic articulation - ideally / almost time-invariantly transmitted to posterity. "Consequently, the EDSAC simulator is textual rather than artifactual in spirit. <...> the attention that other projects have given to physical authenticity has been directed at obtaining authentic program texts. <...> as with musical scholarship, this texual approach permits the informed and explicit filling in of lost textual fragments <...>."[523]

- on "reenactment" Collingwood's 1928 lecture "Outlines of a Philosophy of History", in: R. G. Collingwood, The Idea of History, Oxford 1946 (rev. edn. 1993), 440-443

- temporal behaviour (the "time-window", be it real-time or delay) a criterium for the definition of simulation

- analog computing (different from analog-to-digital conversion of physical signals into data) compatible with the physical (therefore temporal) world itself, when becoming part of the very system which it electro-physically simulates

Analog computing for / as simulation

- message of analoge computing is experimentation: doing mathematics in the engineering way, but different from Claude Shannon's mathematization of engineering

- analog computing different from numerical computing (until the graphical user interface turned the digital computer itself into a quasi-analog machine - on the surface

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522 Edward B. Magrab / Donald S. Blomquist, The Measurement of Time-Varying Phenomena, New York et al. 1971, 1
523 Campbell-Kelly 2000: 399

- analogization between physics and the analogue computer not a construction of cultural knowledge, but an implicit knowledge in nature itself. Again and again scientists have been amazed by the analogous behaviour of a swinging pendulum (a mass, suspended at a leaver) and a "Schwingkreis", an electronic short-circuiting of induction (coil) and capacity (condensors): Fig. 1.1 and fig. 1.2 in: Giloi / Herschel o.J.: 12

- syllogistic common denominator of both operations (mechanical and electrical) a mathematical differential equation

- simulation defined as performing experiments on a model in order to gain insights into the physically real, modelled system; today in most cases this modelling computer simulation

- philosophy of software tools like Simulink (a derivate of the radically matrix-based mathematical tool Matlab, a commercial product of The MathWorks) differing from previous generations of simulation software, in that it is time-based simulation, and Stateflow which is event-oriented simulation; such software based on signal processing, thus respecting the micro-temporalities of signal behaviour itself. Signals are temporal events , defined as "the variation through time of any significant physical quantity occuring in a useful device or system <...> a time-varying quantity" = ???, whereas an emulation re-enacts the functions of an object, simulation rehearses its temporal qualities (Eigenzeit) as well

- temporal behaviour (the "time-window", be it real-time or delay) a criterium for the definition of simulation

Simulation by numbers

- time axis manipulation not easily peformed with physical mechanism, thus engendering knowledge: "Der Erkenntnisvorteil von Simulationen liegt in ihren Extrapolationsmöglichkeit für Bereiche, die zu klein oder zu groß sind, zu schnell oder langsam ablaufen"[524] - chrono-morphing experimental events or even creating "events" which otherwise have not been percetible to human senses.

- digital simulation of physical experiments leading to "artefactual events", revealing mathematical moments of the real: "All discretization techniques present the possibility of roundoff errors or instabilities creating undetected artifacts in simulation results."[525]

- numerical experiments, that is: simulations performed by the digital computer, diagrams gone operative. Inbetween the physical laboratory

524 Gabriele Gramelsberger, Im Zeichen der Wissenschaften, in: Gernot Grube / Werner Kogge / Sybille Krämer (Hgg.), Schrift. Kulturtechnik zwischen Auge, Hand und Maschine, München (Fink) 2005, xxx-xxx (448f)
525 Eric Winsberg, Simulated Experiments: Methodology for a Virtual World, in: Philosophy of Science, 70 (2003), 105-125 (120)

experiment on the one hand, and theoretical physics on the other, such simulations realize a true media theory, that is: Theoretical reasoning is being algorithmically implemented in the real world (like the computer has been born out of a theoretical mathematical question, the *Entscheidungsproblem*). Being in the world - that is, being in time and thus: happening as events, complex models can result in phenomena which have not been envisioned by the author of the program, thus generating unexpected phenomena, which is: information in the true sense of the mathematially informed communication theory in engineering[526]

Computational "society" with Tarde and Latour

- material hermeneutics (and forensics[527]) not caring about "social" implications; media archaeology rather dealing with techno-logical individuations in Gilbert Simondon's sense. Any techological analysis of networks goes down to the hardware (fiber optical cables), protocols (Alexander Galloway) and the source codes ruling communication. Technological objects enact an agency of their own, once their electronics and wiring or storage is read closely, and is - for the moment of analysis - consciously detached from historical, biographical, and social contexts[528], rather looking for non-"social" forces with*in* (or as a *parergon*) of technological formations themselves. Latour's actor-network model liberated the "social" from its limited anthropocentric sense.[529] Still, such extended usage of the term "social" carries with it the metaphorical ghost of a human-like collective. Different from ANT, media archaeology keeps both regimes analytically apart; it rather replaces "society" by cybernetic systems theory. André-Marie Ampère associates in his *Tableaux synoptiques des sciences et des arts* (3. Tableau) the *critique archéologique* with *statistique* (social economy) and *cybernetique* (gouvernment); „l´archéologie <...> va naturellement se placer entre l ´ethnologie et l´histoire".[530]

- ANT not explaining techno-logics; not only that technologies are part of the "texture" of society = Latour, Pandora's box, but the loom itself; requires a radical shift of perspective from outside (intransitive) to "from within" technologies, that is: making their operative enunciations media-theoretically

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526 See Johannes Lenhard, Mit dem Unerwarteten rechnen? Computersimulation und Nanowissenschft, in: Alfred Nordmann / Joachim Schummer / Astrid Schwarz (Hg.), Nanotechnologien im Kontext, Berlin (Akadem. Verl.ges.) 2006, 151-161 (esp. 159f)
527 Matthew Kirschenbaum, Mechanisms. New Media and the Forensic Imagination, Cambridge, MA (The MIT Press) 2008
528 See the Introduction (on "Critical Code Studies") to: Ian Bogost et al., 10 PRINT CHR$(205.5+RND(1)); : GOTO 10, Cambridge, Mass. / London (The MIT Press) 2013, 6: "CCS invites code-based interpretation that invokes and elucidates contexts."
529 See Bruno Latour, Pandora's Hope. An Essay on the Reality of Science Studies, Harvard University Press 1999
530 Essai sur la philosophie des sciences, ou: Exposition anlytique d´une classification naturelle de toutes les connaissances humaines, preface (xvii)

explicit. Source code, executed by computing mechanisms, actually "speaks" itself (Geoffrey Cox)

- B. M. Oliver, J. R. Pierce, and C. E. Shannon, The Philosophy of the PCM, in: Proceedings of the Institute of Radio Engineers vol 36 (1948), 1324-1331 [= "Die Philosophie der PCM", in: Shannon 2000, 217-236]; verbal, diagrammatic and algebraic language describing the techical transfer of speech by pulse code modulation (that is: analog-to-digital sampling, different from FM) is not philosophical but techno-epistemic in the most precise sense

Computing and its "musicality"

- computer processing whatever can be reduced symbolically to a set of numbers and (electro- or otherwise physically) really to sufficiently distinctive binary states

- "The length of numbers in binary notation is at least double that of numbers in the decimal system <...>. This 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."[531]

- every detail regarding phyiscal tone, colour, shape and movement, after A/D sampling, expressed as quantified rows of digital numbers. This world view conceptually resembles that of Pythagoras, creating a media archaeological short circuit between ancient Greece and the present digital reality; the difference is the micro-physical knowledge (and Fourier-analysis) of the vibrational event. The "time" dimension has intervened itself - and at the same time been dialectically mastered by transforming it into the frequency domain

- early musical automata and musical composition games such as those designed by Athanasius Kircher in the 1660s a direct predecessor of algorithmic computer music. 224 These machines relied on automated processes that sys-temised the musical content and performance practices; a more meaningful connection lies not in the programmability of the cylinders and the programmability of modern computers, but instead in the regular revolutions of the pinned musical barrels and the constant clock frequency in modern CPUs

- "musical" demonstration of hard drive's dynamic temporality: Harddisko (2004) by Valentina Vuksic; pieces Analog HD1 (2011) and Analog HD2 (2012) by Gijs Gieskes conceptualise the hard drive's physicality

- media-archaeological understanding of digital media not neglecting the physical real machine, the execution, the operative technology; when taking the physicality and possibility of malfunction into account, then the connections between 5th century Greece and the digital present will look very different. In real signal processing, it is impossible to "count" because counting requires that the machine runs without frictions, that the timekeeping is

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531 Denis Guedj, Numbers. The Universal Language, xxx (Thames & Hudson) xxx, 59

absolute; machine always something more than a symbolic configuration. The operational machine is always trans-symbolic

Algorithmic sociology

- Furet's computer-based *histoire sérielle* not simply mathematically investigating "big data" (quantiative history) but identifying patterns and correlations (close to "Digital Humanities" today), "temporal series", "given intervals", generally measured "annually" - new *annalistic*; minimal music which somewhat sonifies such temporal series which extend to non-anthropocentric series of data[532]

- algorithmic sociology as predictive statistics. "Will we become the atoms in the 'social physics', first dreamed by the founder sociology Auguste Comte in the middle of 19th century?", Lev Manovich asks in his presentation of an algorithmic tool to compare facial expressions in "selfies" collected from social media such as Instagram in order to detect the distinct "visual signature" of individual cities (online communication by Lev Manovich, May 2014; www.selfiecity.net). Gabriel Tarde in late 19th century developed an expressed 'archaeological' sociology, closer to statistical data operations than to human subjective or collective agencies = Gabriel Tarde, Les lois de l´imitation, Paris (Félix Alcan) 1890, chap. IV (Qu´est-ce que l´histoire?), section „L´Archéologie et la Statistique", esp. p. 99 and 114; „Il est le plus propre à éclairer les faits sociaux par leur côté régulier, mesurable et nombrable"; „il s´ensuit que la statistique sociologique decrait s´y placer", by „enregistrements stériles", in fact „l´emploi de la méthode graphique de M. Marey ou l'observation des maladies par le myographe, le sphymographe, le pneumographe, sortes de statisticiens mécaniques des contractions, des mouvements respiratoires."[533] In *Le Mouvement* (1894), Marey calls the graphical curves "the language of the phenomena themselves"[534]. Tarde defines "les études archéologiques et les études statistiques"; statistians, like the archaeologist, „jette sur les faits humains un regard tout abstrait et impersonnel" - Foucault's posthumanistic archaeology not *avant*, but *à la lettre*[535]

Discrete methods: Writing the past retro-actively

- radical media archaeology a non-historicist investigation into technologies from the present past; by-passing contextual information about past media, but a close reading which gets into contact with technological media in their radical operability and temporality itself. Media archaeological as research method restrains from interpretative approach in history of technology but shares the

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532 Kusch 1991: 20, referring to serial history in terms of Le Roy Ladurie. See François Furet, Quantitative methods in history [FO 1971], in: Jacques LeGoff / Pierre Nora (eds.), Constructing the Past, Cambridge (Cambridge UP) 1985, 12-27 (14)
533 Gabriel Tarde, Les lois d´imitation, Paris 1890, 122f
534 Quoted here after Giedion 1982: 40
535 Gabriel Tarde, Les lois de l´imitation, Paris 1890, chap. IV (Qu´est-ce que l´histoire?), Absatz „L´Archéologie et la Statistique", 99 u. 114

techno-mathematical situation of media machines in their non-historical presentness. Their functioning operations are the media archaeological moment that is at its core un-historical; see Jussi Parikka, http://mediacartographies.blogspot.com

- occasional / event-driven technologies; dynamic media archaeography as it happens in the stored-program computer (von Neumann), in synchronous layers, describes techno-logical recursions, dis- and replacements (McLuhan's "tetrads")

- "Freudian concept of 'retroaction' (in French "après coup"; from German "Nachträglichkeit"); Digital Retroaction: A Research Symposium (The Digital Cultures Project), UC Santa Barbara, September 17-19, 2004; "retroactively" the operations of digital data processing in the present redefining understanding of cultural engineering in the past

- in digital data circuits, "retro-action" not a translation between the past and the present any more, but a cybernetically closed circuit (the feedback-option / back channel). When we load a document, it does not come from a materially, but just logically separated "storage" space (the von-Neumann architecture of computing merges programs and the data to be processed dynamically into the same working memory); computers "retro-actively" transforming narrative aesthetics into non-discursive configuration of events - a formal, algorithmic chronography

- digital media today transforming the present immediately into past ("antiquity", according to Walter Benjamin) by the very speed technological formats and data themselves pass by; "media archaeology of the present" leads to a different perception; past suddenly turns out to be storage - a digital retroaction. Since the tradition of the past suddenly looks like "a medium, in which past idas and meaning is present in a coded form" = Ulrich Veit et al., Spuren und Botschaften. Interpretationen materieller Kultur, Münster / New York 2003, 11; be it material artefacts or records. As long as a culture stores its knowledge in pyramids or DVDs, archaeology as technology of revelation will be practices but might become redundant in a culture which switches from the mode of storage to permanent transfer

- electronic computing where electronic circuits perform logical operations; technical term for this is "inductive retroaction" (flip-flop, designed by Eccles / Jordan 1919). The digital computer operates in terms of numbers represented by simple pulses (a reverse interrelation between physics and representation). Information, numerical *or otherwise*, is represented by means of distinguishable (discrete) characters

Er/zählen: narrative *versus* calculation

- Alan Turing's notion of a computing mechanism to calculate computable (real) numbers based on the unconditional assumption that this machine can only exist in discrete "states"

- nondiscursive, algorithmic configuration of events; operation of the machine

itself has no discursive agenda, or agency, other than to execute a specific task of functionality

- writing itself not derived as means of communication, but of calculation - with the proto-Sumerian counting "tokens", truly digital. "Counting by numbers": Media archaeology stratigraphically dis/covers a layer in cultural sedimentation which is neither purely human nor purely technological, but literally inbetween (cultural techniques): symbolic operations which turn the human into a machine as well as they can be performed by machines (once that numbers were abstracted from the material things and could then be re-implemented in matter again, as "calculi" - as analyzed by the archaeologist Denise Schmandt-Besserat (stones included in a clay cube, sealed, with their written on it) or in computer hardware)[536]

- while Pythagoras saw integer ratios embedded nature (like Leibniz´ "deus calculans"), computer literally numbers the world; Leibniz´ speculation on the possibility of an eternal recurrence of things, *Apokatastasis panton*. „The alphabet encompasses the world" writes the German Brockhaus Encyclopedia; more strictly, the alphabet only registers what can be addressed by symbols. Leibniz´ literary fragment *Apokatastasis panton* culminates in the option for an imaginary library in which whatever has happened in human past could be shelved - by consequentially performing all possible combinations of letters.

- "The power of repeating the cards <...> reduces to an immense extent the number of cards required", Ada Lovelace comments in her "Note F" (Lovelace, in: Bowden 1971: 395), and hereby describes the power of recursive loops in algorithmic operations: "It is obvious that this mechanical improvement is especially applicable wherever cycles occur in the mathematical operations, and that, in preparing data for calculations by the engine, it is desirable to arrange the order and combination of these processes with a view to obtain them as much as possible symmetrically and in cycles" = ibid.; von- Neumann architecture of stored-program computing actually allows for self-modifying (input-adaptive) calculations in realtime

- task looks immense but is finite - as long as the alphabet is a finite one. Only whatever has been recorded in symbols can return by this play of alphabet.[537] The 23 Latin letters once saluted by Lucretius as elements of an unlimited combinatorics of thought[538]. Leibniz´ effort to *calculate* a virtual protocol of the world epistemologically still refers to the genre of Annals and Chronicles "by which everything that can be told can be found"[539]. The alphabet is the *type-writer* of narrative - the condition which governs what can be told at all - "everything between past and alphabet" (John Cage); whatever cannot be

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536 Denise Schmandt-Besserat, Before Writing. From Counting to Cuneiform. Austin/Texas 1992

537 Ulrike Steierwald, Wissen und System: zu Gottfried Wilhelm Leibniz´ Theorie einer Universalbibliothek, Cologne (Greven) 1995, 65

538 *De rerum nat.* 1. 823-827.

539 Leibniz to Herzog Johann Friedrich von Braunschweig-Lüneburg, ca. 1671. See Hans Blumenberg, Die Lesbarkeit der Welt [*1983], 3rd ed. Frankfurt/M. 1993, 121-149 (128ff), on Leibniz´ spectulative *Apokatastatis* (fragment 1715)

registered in discrete letters will escape memory: „semper enim forent discrimina etsi imperceptibilia et quae nullis libris describi possint" = Gottfried Wilhelm Leibniz, Apokatastatis panton, published in: Max Ettlinger, Leibniz als Geschichtsphilosoph, München 1921, 31; see Bernhard Siegert, Frivoles Wissen. Zur Logik der Zeichen nach Bouvard und Pécuchet, in: Hans-Christian v. Herrmann / Matthias Middell (eds.), Orte der Kulturwissenschaft. 5 Vorträge, Leipzig (Universitätsverlag) 1998, 15-40, esp. 28-33. Leibniz even reduces this digital alphabet to two (binary) symbols only: "Wonderful origin of all numbers from 1 and 0, which provides an image of the secret of creation, since everything stems from God and otherwise from nothing: Essentiae Rerum sunt sicut Numeri."[540]

- discrete processing at odds with continuous recording; can continuity be calculated. Once energy is turned into electricity (our physical basis of information processing), we already move within a discrete universe, since electricity is not a coherent, continually disseminating flow or fluid, but rather composed of discrete elements[541]; natural language made up of discrete, finite elements (phonemes) so that all descriptions of continuous processes happpen by a finite discrete sequence of finite elements = Pattee 1974: 130; Leibniz offering a solution by his differential and integral calculation: "A continuous dynamical system, such as the motion of several mass points in a potential field, can be calculated in practice by approximating the values of the continuous variables over a discrete mesh, and representing the mesh behavior by an automaton."

- "data" derived from whatever can be measured and thus recorded. Remains what is being filtered out by digital registration - impercetible differences which are not being remarked by human senses (aisthetically) and electronic sensors (CCD chip)

- media archaeology dealing with the new possibilities of "petits perceptions" (Leibniz), i. e. the subliminal operations (of nerves: von Helmholtz) as well; Shannon-Nyquist interpolation theorem, the media/anthropological interface between what humans (aesthetics) and machines (media-aisthetics) processually perceive. René Descartes referred to the slow growing of tree day by day: Who has ever noticed the little elements operating to make this tree grow? Such elements are so small and slow that they cannot be remarked naturally. But digital culture nowadays privileges an over-sampled reading of such processes

- once pixeled, that is: digitally coded, an image losing all continuous information, that is: information "inbetween"; a digital image of a pebble beach can easily be compressed, that is: calculated. Latin *calculatio* is derived from calculi themselves, that is: counting with pebbles in the sand. Now we reach the limit of digital computing: Although his heart (micro-ship) is materially built on sand (silicium), he is not able to calculate the random distribution of sand

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540 Letter by Leibniz, 18 May 1696, quoted after: Hans J. Zacher, Die Hauptschriften zur Dyadik von G. W. Leibniz. Ein Beitrag zur Geschichte des binären Zahlensystems, Frankfurt/M. (Klostermann) 1973, 209

541 Laszlo von Szalay, Moderne Technik. Elektrotechnik, Berlin (Safari) 1954, 386

without aliasing effects. And a human image drawn into the sand will (with an allegory designed by Michel Foucault) vanish in specific waves in ways no digital computer will ever be able to emulate (except quantum computing). This image, after a while, will rather look like the jammed images in early analogue TV

Computers avant la lettre? Writing media history as media archaeology

- crucial difference between the "Renaissance computer" logic and technological machine metaphors, and the machine itself that actually in a real physical process handles the data, and not just a symbolic calculation of data; even if the theoretical foundation for the development of the computer was present many centuries before its physical manifestation, there is a substantial difference between regarding the computer and its theoretical foundation solely as a symbolic machine and regarding it as a physical object that actually conducts the calculations in a real physical process

- Neil Rhodes / Jonathan Sawday (eds.), The Renaissance computer: knowledge technology in the first age of print, London / New York (Routledge) 2000, Introduction: Paperworlds. Imagining the Renaissance Computer, 1-17

- "Knowledge of automatons, or of clockwork toys, played no part in the story of cinematography, nor is there any link between it and the production of animated 'scenes'. We can therefore omit plays, the baroque automatons, and the marionette theatre. Even the 'deviltries' of Porta, produced with the camera obscura, the phantasmagorias of Robertson, the 'dissolving views' of Child, are not to the point. All these discoveries did not lead to the first genuine moving picture sequence" = C. W. Ceram´s *Archaelogy of the cinema*, as quoted by Erkki Huhtamo, "From Kaleidoscomaniac to Cybernerd. Towards an Archeology of the Media" = http://www.debalie.nl/dossierartikel.jsp;jsessionid=7E2098DE44FCDF3B4368D0 87406665AF?dossierid=10123&articleid=10104

Streaming: The digitization of records from the past

- light and sound signals belonging to the regime of the real, while their digital sampling translates them into the symbolical, that is: countable (accessible for computing) as frequencies. But within sampling, quantization errors occur: the real always returns (Lacan)

- media-archaeological recording primarily memorizing the noise of the wax cylinder itself - technologically, a different kind of information on the real. Media archaeology opens our ears to listen to this as well, not to filter this out (against the "cocktail party effect" of hermeneuticised psycho-acoustics); phonograph as media artefact does not only carry cultural semantic like words and music, but is at the same time a frozen, implicit (en-folded) knowledge of its engineering as well, by its very material fabrication, which- waits to be de-frozen, liquified

- with an analog-to-digital converter, the sampling rate controls how many samples are taken per second / per year (in the case of the St. Gall annals) - all depending of the quantization level. On the time-axis: year 700, 701 .... and sine wave of events / sampling time; annals as the graphical indication of a conscious quantification, that is: digitalisation of temporal processes - the abstraction of a temporal-successive quality as a geometric, thus static figure, no history at all

- Fourier transformation of a temporal function or sequence of signals into a spectrogramm; not historiography any more, dealing with macro-temporal processes, but genuine mediography which deals with temporal micro-events, with time-critical operations

- for each private live hour of an individual, Leibniz calculating 10 000 letters and thereby makes live finitely countable, explicitly annalistic[542]

- according to Norbert Wiener, telegraphic transmission of a human being, if sufficiently describes as information; "streaming" data a metaphorical disguise; see media art installation Jim Campbell, *Church On Fifth Avenue*, 2001: Jim Campbell, *Church on Fifth Ave* (2001): passengers pass through screen, transform from discrete into continuous appearance. Custom electronics; movie: http://www.jimcampbell.tv: "A matrix of 32 x 24 (768) pixels made out of red LEDs displaying a pedestrian and auto traffic scene in NY from an off street perspective. There is a sheet of diffusing plexiglass angled in front of the grid. As the pedestrians move from left to right the figures gradually" - continuously, or in discrete steps? - "go from a discrete representation to a continuous one (or metaphorically from a digital representation to an analog one)." But even the impression of continuous movement, in digital projection, is always already discrete; see the artefacts at margins of the Campbell insetallation QuickTime Movie. The analoge becomes a nostalgic re-entry

- dis-affection; media-archaeological gaze adequate to machine aesthetics itself which is implanted into the human *mind* (like Turing could imagine the human as "paper machine"

Programming

- archaeology of Russian computational thinking not restricted to paper-based research in State archives or explicit oral history interviews, but implictely embedded within the machines themselves

- "After American weapon factories during the Civil War had already delivered guns which exchangable parts, World War One extended the exchangability of guns like the notorious 08/15 to an extend that its single parts could be produced in bicycle and typewriter facturies as well. Only such really modular systems, as having been claimed by Babbage for his proto-computer already, inagurated the option of programmable hardware to a limited degree [...] while a digital computer can be structurally programmed" = Friedrich Kittler, Hardware, das unbekannte Wesen, in: Lab. Jahrbuch 1996/97 für Künste und

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542 Leibniz in Ettlinger 1921: 29

Apparate, edited by Academy of Media Arts, Cologne 1997 (Walther König), 348-363 [transl. W. E.]; Michael Conrad, The Prize of Programmability, in: Rolf Herken (ed.), The Universal Turing Machine. A Half-Century Survey. Hamburg-Berlin 1988

- irreducible asymmetry between time- versus storage-orientated economy in computing linked to the most basic level of programming aesthetics; though to write a program in the programming language is easier, it can not be used directly since it must first be translated into machine codes. After the translation, the program written in machine languages again becomes 3-6 times longer and needs 3-6 times more memory; time saved in preparing the program had to be paid with increased memory, that is by a still larger amount of hardware

(back) into counting: "Radical" media archaeology

- humans count (add) numbers by fingers; binary computer, on the contrary, adds numbers by gates, derived from Boolean logics: digital-electronical circuitry for adding binaries; the logical and mathematical implications; cp. *analog*-electronical adding circuitry: physical voltage, or even more basic: analogical adder with wire ropes (Lego or Fischer Technik)

- no "GO TO" for "for / while"

- computer the operative entanglement of logics and matter: therefore it counts rather than narrates - close to the machine where algorithmics precedes narrative

- "radical" refers to the affinity between media archaeological analysis and mathematics, epitomized in the radical square root. Fundamentally media archaeology understands the *arché* in its mathematical sense: algorithmic rooting in numbers; Lacan, on the intrusion of symbols like the square root: this happens all of the sudden, but still creates its own (pre-)history

- digital computer (on silicium chip) does not count with positive or electric electrons (0 / 1), i. e. charges (Ladungen) but with electric force (voltage / Spannung). "0" symbolizes not a single electron but a whole assemblage, sufficiently different in numbers from symbolical "1" = significantly other voltage (ex-5 V, now: 3,3). Statistical rather than exact amount - the oppositive of what adding of whole numbers (integers) appear as on the symbolical level. There is no truly "binary" adding but physically fuzzy numbers of electrons (like electron "shot" effect in vacuum tubes as binary switches). Becomes critial only on the quantum-computing level

- addition / counting time by seconds: clock mechanism; Mumford, Technics and Civilization, 1934 / 1963

- UNIX time, atomic time clock (PTB Braunschweig), "broadcast" via DCF77: de-couples "cultural" time from natural astronomical time, creating anachronisms which are compensated by leap seconds. A media-epistemological moment: cultural techniques of time-keeping transform into trans-cultural technologies.

Within the computer, there is both a physical clock (called "realtime clock", hardware: quarz oscillator) and a logical clock (software); computing turns time-measurement into information, resulting in "multiple times"[543]

- according to Helmholtz, inner ear acts as a Fourier analysator; computing (analog / digital) within hearing; electronic non-human voice synthesis nothing but another version of what is inside the human understanding already where the physiology of hearing privileges "musical", i. e.: harmonic sensation; Ferdinand Trendelenburg, Klänge und Geräusche. Methoden und Ergebnisse der Klangforschung, Schallwahrnehmung, grundlegende Fragen der Klangübertragung, Berlin (Julius Springer) 1935, 13

- central register named ›Accumulator‹ in early-Mikroprozessors (8-Bit-Prozessors) like Z80, where arithmetic and logic operations take temporarily place

Still human? Counting with fingers

- Leroi-Gourhan, human hands enabling tasks resulting in cultural techniques; elementary fingers which literally lead to digital counting in its most basic form: adding to ten decimal numbers.

- intuitive tuning instead of counting the slide rule; difference between machine and instrument; adding without numbers

- mechanical mathematical operation. "Adding" to which all computing can be reduced is a kind of archaic symbol operation: when counting, humans are in a machine state; adding with fingers not simply a cultural technique any more (defining culture as symbolic act), but already an externalization of the animal (body). The media-archaeological approach removes the borders between human and machine: with the counting hand already as "extension" of man, as prosthesis, as first media coupling of the body

- mechanical "adder" mechanism: fig. "mechanische analoge Addierwerke" in: Pflüger 2005: 30. Pflüger asking "ob der Computer überhaupt 'rechnet'"; rather: "symbol manipulating device", operating on binary symbol chains. Rather information processing in terms of entropy (Shannon); "Rechnen im herkömmlichen Sinn stellt dabei nur eine operative Möglichkei tunter anderen dar." Opening the notion of computing.

- treating binary discrete electronic states as "numbers" an arbitrary symbolization; binary computer: counting with integers; analog computer: real numbers

Human and / or media-archaeological moments: computing

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543 See Jeremy Rifkin, Uhrwerk Universum. Die Zeit als Grundkonflikt des Menschen, Munich (Kindler) 1988 [A0 Time Wars, 1987], 134, referring to David Bolter, Turing's Man

- pressing a key on a computer keyboard usually associated with some kind of symbolic meaning, as part of a word, a sentence, forming longer sections etc., which consequently then gets displayed on our computer screens, making us able to read it. But, through a media archaeological viewpoint, the keyboard sign is transformed into a electro-physical signal, thus loosing all its semantic referentiality and becomes a coded element, an electrical signal, within a physical computer, loosing the traditional symbolic meaning and gaining electro-physical indexicality. This introspective of the "algorithmic sign" (Frieder Nake) induces a more diverse understanding to the relationship between encoded symbols and their physical manifestation - a non-discursive, algorithmic configuration of the alphabetic symbol as signal events. The symbols loose their semantic meaning and become electrical indexes that have a new meaning and application inside the electro digital circuity.

- for FlipFlop circuit as signal event to happen, not necessary to know the genealogy of this technological device; the technical event functions like an analog version of the Markov chain: probabilities of immediate future behaviour is dependent only on its present state

- "calculating machine" post-human (Kittler) or rather intra-human (Turing 1936 / Lacan)? cultural or equi-primordial (implicit) knowledge? Krämer, *Symbolische Maschinen*, 4: Genealogy of logical formalisation "in der wir gelernt haben, uns beim Operieren mit Zeichen so zu verhalten, als ob wir eine Maschine seien." While for Kittler elementary cultural techniques are absorbed in technologies, Krämer still defends habituation: "Eine Kulturtechnik ist für eine Praxis, die so transparent ist, dass sie nicht mehr bewusst erkannt wird"[544]; *dissimulatio artis* in rhetoric

- theoretical distinction by Jacques Lacan, the real, the symbolic, and the imaginary: "We learned to read RSI as gramophone, typewriter, and film" = Axel Roch, Hegel is Dead: Miscellanea on Friedrich A. Kittler (1943-2011), in: Telepolis (November 17, 2011); http://www.heise.de/tp/artikel/35/35887/1.html (accessed June 26, 2017)

Archaeology, Computing

- the very term "memory" for permanent (ROM) and ephemeral (RAM) data storage in early digital computing; instructions like "Memory" in the text saving menues of computer software a semantic archaism. The difference between procedural presence and storage of data is a function of directing codes; during the the second Gulf War both missiles and news (about missiles) were in principle transmitted by similar (or same) electronic rays

- memory not linked to the past but rather radically present; mathematically informed archaeology practicing *cluster analysis*; historiographic concepts of past times nothing but a narrative disguise of material entropy, the final equilibrium into which accumulation transforms. *Cluster analysis* is a non-

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544 Arndt Niebisch in Pál Kelemen et al. (eds.), Kulturtechnik Philologie, Heidelberg (Winter) 2011. : "Die Liebe zur Ziffer. Positionen einer posthumanen Philologie", 163-183 (177), parphrasing Krämer

discursive statistical technique, the true memory of waste; computer disposes of a better memory of waste *to count on*; only its calculating operations are able to make sense out of apparent disorder

- computational *imagineering* as metonymic transformation of non-intuitive data into graphics; Thomas Quarry announcing it in an advertising for IBM from Casablanca where Jean-Jacques Hublin unearthed a few fossiled skull fragments. Hublin and a team of IBM scientists "fed this shattered jigsaw puzzle into a unique program called Visualization Data Explorer. The tiny pieces helped form an electronic reconstruction of our early ancestor, the first Homo sapiens. This new IBM technology has turned time back 400.000 years, uncovering clues to the origins of mankind"[545]

- Sphinx sculpture in front of the Cheops pyramid restored by aid of computer in detail; Mark Lehner of the Oriental Studies Institute (University of Chicago in Illinois) has overlapped photographies of the sphinx with portraits of pharaoe statues and by photogrammetric composite pictures reconstructed the most probable archetype of the sphinx which might bear the features of pharaoe Chefren (4th dynasty)[546]

- project undertaken by the Parisean École Française d'Extrème Orient, dealing with the reconstruction of the nine hundred years-old ancient Baphuon temple of Angkor in Kambolia; 500 000 stones, scattered around the ruin, to be restored to their previous placement. An infographics company provides three-dimensional photographies as computer modelling of the temple, serving as conceptual grid to insert the fragment into.[547] Once again, the computer provides a better memory of waste than historical, that is: human imagination can cope with

Both discursive and nondiscursive: "Media archaeology of the stack"

- *online* magazine AMODERN no. 2 (2013), thematic issue "Network Archaeology": Rory Solomon, Last In, First Out. Network Archaeology of/as the Stack, http://amodern.net/article/last-in-first-out: stack = a) "an operative structure that exits materially within the program code of software systems"; b) "a class of diagrams" which only come into being when becoming time-operations

- physical media channel as nondiscursive infrastructure for the passage of discursive enunciations; triodes / transistors as discrete media channel?

- physical hardware and hidden data processing algorithms of computational media as subsemantic layers, *both* discursive (source coding) and nondiscursive (operationally implemented)

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545 In: *Wired* 3.03, March 1995
546 Notice in the *Frankfurter Allgemeine Zeitung* from 15th July 1992
547 "Steine mit dem Computer sortieren", in: *Frankfurter Allgemeine Zeitung* of 12th April 1995

"Toward an Archaeology of Algorithmic Architectures from Within"

- concept "living architecture" as programmable matter; Andrew Goodhouse (ed.), When is the Digital in Architecture?, Spike, Berlin, 15 June, 2017; integration of computing "architecture" into architecture proper

- a media archaeology of algorithmic architectures from within" the digital itself, the computer, more precisely: the so-called "von Neumann architecture" of stored-program computers in the techno-logical sense: its architecture (electronic hardware, *techné*) and archive (software, *lógos*)

- both "archives" and "architecture" about tectonics / structure; computer engineering first three-dimensional, *housing* thousands of electronic tubes, then, with Integrated Circuits, becoming more and more (Moore's law) two-and-a-half-dimensional; such a circuitry not only *is* but *has* an architecture

- archaeological entropy is re-versed by informational entropy: In 1896 A. S. Murray visited the ancient site of Ephesos and reports about a state of entropy: "The entire area was overgrown with vegetation, and the few visible remains were lying about in such confusion that no definite plan could be distinguished <...>"[548] - kind of disorder which human capacities of *pattern recognition* can not decipher any more; only as data arrays such traces become readable again by a different architecture - the architexture of computational microchips

- computer application in Archaeology proper: quantitative / statistical analysis; Geographic Information Systems (GIS), linking data to maps; surveying of excavation, topographic and geophysical data; on-site recording of excavations and post-excavation analysis; graphic display (synthesis) from same data set, reconstructions and simulations

- ruin (heap of stones) of former *Frauenkirche* cathedral in Dresden transformed into a serial magazin of shelves storing the array of the individual stones which are being digitally registered by computer programs in order to reconstruct the building out of its scattered elements. The virtual reality of the *Frauenkirche* is interval memory, memory *in the meantime*[549]

- Geoffrey Shaw's *Legible city*, a version of which even exits for Karlsruhe, builds urban architecture by letters, thus rendering spatial data symbolically readable = Lev Manovich, Die Ästhetik des naviigierbbaren Raums, in: Katalog vision.ruhr: Kunst, Medien, Interaktrion, Zechhe Zollern II/IV Dortmund, xxx, 84-90 (87); if a virtual space rooted in real world at all, it is the materiality of the computing device itself; 3-D-spaces always reflects the graphic power of SGI workstations

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548 Quoted after David George Hogarth, *Excavations at Ephesos, The archaic Artemisia*, London 1908, "Preface"
549 See Edmund Hug, "Letztlich eine Frage der Architektur", article on the CeBIT '94 fair at Hannover, in: *Frankfurter Allgemeine Zeitung* of 15th May 1994

- against the theatrical paradigm of "computers as theatre" (Brenda Laurel), that is: the visual Interface, McLuhan's notion of "acoustic space": computers rather as concert hall; sonic approach to (literally) "understanding" of processual algorithmics (alternative to Asymptote's *New York Stock Exchange* visual Data-Metaphors; an alert is better addressed to time-critial ears

- OPERATIVE MEDIA PRESERVATION of early digital works in architectural design linked with the challenge of RE-ENACTING (TECHNO-)LOGICAL MACHINES; ahistoricity of / in computer architecture. How to exhibit computational machines? Doron Swade, as curator of the computer department at the London Science museum, pointed out this challenge for curators. "It's very complex to preserve software on the original hardware; the new option is to emulate the former computer architecture itself as software in order to display its programs (be it computer games, or dynamic media art). It has to do something and then you need again the running system to operate this software" = Swade 1998: 195

- an algorithm surviving its actual electronic implementation; techno-archive's "two bodies" (Kantorowicz) are the tectonics of computer hardware (in its von-Neumann architecture), and its algorithmic codes

- possible attendance to software performance: breaking the logic of computing itself by switching to another medium such as sound; sound as configurations of data (once oscillations have become calculable); sonicity as temporalized technology accessible *via* the ear, the human time organ. By *auralization* of computer architecture so that we can listen to the rhythms of algorithms and access microtemporalities; listening with a media archaeological ear not to content (music), but to the sonic dimension of computational architecture

"The gesture of programming" (with Flusser)

- media-archaeological devices from early electronic computing to demonstate how hardware to perform discrete numerical operations - nowadays almost exclusively be associated with integrated circuitry - literally transfered from a voice communication technology, such as manual telephone switchboard

- Flusser on "gesture" of telephoning; concentrates on dialling. In the analog mode, numbers from zero to nine which can be dialled not manually but usually by the index finger. The meaning of "the digital" in current media culture refers to computer-based technologies. More precisely, the real "message" of the digital (in McLuhan's sense) is the binary code - which in fact reduces the hands with 10 fingers (Latin *digitus*) to just two micro-movements of on/off gestures. This is bound to decimal arithmetics (logarithm basis 10) which shifts to logarithm basis 2.

- the hand "human" at all, or half way to a machine (mechanism) already, an interface in the technical sense? uncannyness of the hand: humans not sure any more - faced with robotic and other prosthetic "hands" - that this is an integral human body part, its extension of even its autonomous brain-hand-system in the cybernetic sense

- doing things symbolically ("machine notation", with Babbage) vs. wiring / patching manually, close to the "real" of hardware

- "Archaeological *data* consists of recorded observations. These might be measurements of the size of a handaxe, the stratigraphical relationship between two layers or the geographical location of a site. Whilst archaeological data is frequently numeric, it can equally well be non-numeric, such as the name of the material or colour of a object. It also comprises visual data, such as photographs, plans or maps. Data *processing* is the name given to the manipulation of data to produce a more useful form, which we shall call *information*. <...> The sequence of operations required to perform a specific task is known as an algorithm" = J. D. Richards / N. S. Ryan (eds), Data Processing in Archaeology, Cambridge U. P. 1985, 1 f.

Digitality instead of the whole "hand"

- digital "sampling" ("Abstasten") - the central momentum in the conversion of analog signals in the physical world to numerical computing - corresponding with the discretization of the human hand into single "fingers" (Latin *digitus*); for Marshall McLuhan, even the cathode ray in the television tube is a "scanning finger" which is a *massage* to the retina in the human eye. With McLuhan's extension of the "haptic" qualities and of tacility to *all* senses (not just the finger tip), all of the sudden, even if he seems to have neglected the emerging computer as medium[550], he is a media-archaeologist of the "digital": "Our very word 'grasp' or 'apprehension' points to the process of getting at one thing ghrough another, of handling and sensing many facets at a time through more than one sense at a time. It begins to be evident that 'touch' is not skin but the interplay of senses."[551]

- difference between the nature of haptic (acoustic) and electro-magnetic (visual) signal sensation matters. While Aristotle could not admit a self-induced signal transfer like it happens since James Clerk Maxwell discovered the nature of electro-magnetic wave dynamics, he had to suppose a fictional medium called "ether"; for the Aristotle all signal transmission happened in a material, almost haptic medium (*to metaxy*)

- for age of electricity, McLuhan identifying return (reoccurrence) of the primordial (oral language-controlled) "tacility". Its decisive criterium is its (almost) instantaneous speed of transmission. With electric media - not to be confused *electronics* and with strictly more "digital" electronic computing - begins the technical formation of tactility[552]

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550 See Claus Pias, Die Welt des Schmoo, in: de Kerckhove et al. (eds.) 2008: 140-157
551 Marshall McLuhan, Understanding Media,New York et al. (McGraw-Hill) 1964, 60
552 See Till A. Heilmann, Digitalität als Taktilität. McLuhan, der Computer und die Taste, in: Zeitschrift für Medienwissenschaft 3, no. 2 (2010), 125–134 (128)

- correlation between discrete arithmetic numbers / cultural technique of counting with fingers: "All of these anticipate later electric forms because, like the digital computer with its mulitple yes-no dots and dashes, they caress the contour of every kind of being by the multiple touches of these points. Electricity offers a means of getting in touch with every facet of being at once, like the brain itself. Electricity is only incidentally visual and auditory; it is primarily tactile"[553]; electric current stroke / impulse; pointillism, Morse code) pre-figuring digitality; sampling of analog signal qualities (image telegraphy / television)[554]

- Henry Fox Talbot envisioning, with chemical photography, the liberation of visual art from the painterly hand. "[...] photography made people realize that art was not necessarily the manipulation of a plastic substance like paint or materials of any kind. It is an act of selection, you press the shutter."[555] In a kind of unexpected recursion the artistic hand comes back to the picture, but not in a painterly mode any more: "The artist no longer directly touches or manipulates color, material, or objects. He or she manipulated algorithms, which are more or less abstract" = Abraham A. Moles, Introduction to conference *Computers and Visual Research*, Center for Culture and Information, August 3-4, 1968, Zagreb, reprinted in: Margit Rosen (ed.), A Little-Known Story about a Movement, a Magazine, and the Computer's Arrival in Arts. New Tendencies and Bit International, 1961-1973, Karlsruhe (ZKM) / Cambridge, Mass. (MIT) 2011, 263-266 (265)

- finger(s) on the Morse key / telegraphy; Heilmann 2010: 133: the world of the symbolic (order); counting with fingers / mathematization / mechanizations: "fingers-on", only two fingers: binary, typewriter MIGNON

- programming in *assembly languages*; these machine orientated languages „do things" directly = "The Gesture of the Programmer" (Stefan Höltgen, abstract conference Brünn, 2014). In the sense of John L. Austin, they connect elements of hardware; they make the electrical signals flow in a distinct way through the circuits; and beyond all that their syntax and semantic stand for a theoretical model for the computer itself (Turing completeness). So the coder at the keyboard becomes much more than only a writer/autor of code. He applies a theoretical "symbolical" machine to a physically real machine; programming forces the „universal Turing machine" to become a „special purpose machine" – only by using words from a special alphabet, the programming opcodes

Not hands, but fingers: the "digital"

- Jeron Lanier 1989: presentation of a "data glove"; immersion / reentry of "mani"pulation in form of the computer mouse / the pointer on the screen

- limited manual precision in anloge computing with sliding rule; "on the other hand" infinite variability of "real numbers" which the digital computer always

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553 McLuhan 1964: 247 f.
554 Heilmann 2010: 131
555 Jonathan Benthall, The Computer as Medium, in: Rosen (ed.) 2011: 461-465 (461)

misses; Abakus: discretisation. Numerical computing turns the hand into fingers: "analysis" (elementarization) with which symbolic notation (alphabet / numerical mathematics) corresponds different from geometrical drawing

- hands on instruments: *soldering* as opposed to type-writing (and programming for digital mechanisms); in TM reduced to two "keys" (binary code / bit)

Hand-writing *versus* type-writer

- Nietzsche's use of typewriter inducing a different kind of reasoning; key-board of Nietzsche´s Malling Hansen; animation of the transporting ribbon mechanism, clock-like; implicit Turing machine; analyse Nietzsche´s typewriter (at the Weimar Classic Collection) by writing: an operative analysis, where any textual hermeneutics of the poems written by Nietzsche on this very machine cannot reveal his experience with the ostacles of the mechanism. It is in their operativity that technical media *time-criticvally* (crucially) unfold

- media-archaeological view of early printing culture: not appearance (the Gutenberg Bible emulates handwriting, with the previous medium being the "content" of the new one according to McLuhan's law of media); technology of identical (re)production: identical "letter" casts from matrix negative

- media revolution not printing as such (in fact the typography of the Gutenberg Bible explicitly tries to emulate the appearance of the illuminated handwritten manuscript - with the previous medium being to content of the following one). It is rather the hidden technology of identical casting of metal letters (not the writing as such) from a master mould which lead to a new technological mode of identical reproduction of textual knowledge (and printed illustration, giving rise to scientific knowledge exchange - as emphasized by Elisabeth Eisenstein's classical study on the Printing Press as an Agent of Chance). Once more, media archaeology rather focuses on the non-discursive technological pre-conditions of discoursive knowledge in the Gutenberg era.)

- Russia and Persia around 1850 establishing telegraph lines on their territory to facilitate communication with the Indian sub-continent; lines suffering from heavy signal degeneration over space; therefore a readable telegram between London and Kalkutta was rather improbable through the agency of personel with deficient language facilities; solution their replacement by non-human repeater-regenerators

Machine-writing

- term "manu-script" not relating to human hand-writing any more but the typographic original of the printed book[556]

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556 See Peter Stein, Schriftkultur. Eine Geschichte des Schreibens und Lesens, Darmstadt (Wiss. Buchges.) 2006, 176

- alphabetic writing (MCLuhan) pre-conditioning epistemology of analysis (elementary practive, combined with the eye: reading), *vgersus* "acoustic space" (returning with electricity)

- hand-driven phonograph / grammophone (Emile Berliner, original version; photo: Replica MAF); the ear much more sensitive to unregularities. "Bei der Wiedergabe musikalischer Töne macht sich jede Unregfelmäßigkeit bei der Drehung der Walze, die ja durch Handbetrieb erfolgt, unangenhme bemerkbar."[557]

- hand-held endoscope / stethoscope in medicine *versus* ultrasound image; artefactuality of the camera objective

The inhuman / machine within / defining the "human"

- identifying the sub-phenomenal machinery / media-archaeology of infrastructure: reconfiguring of "the human"; technology (or the robot) not outside of, or separable from, the human, "in both a conceptual and material sense, just as humans are not separable from machines" = David Savat / Christina Chau, Anxious Robots, Desiring Repression, Generating Profit, in: Transformations issue 29 (2017), 52-xxx (53); following Lewis Mumford, Félix Guattari, Gilles Deleuze, "we argue that machines are social, and that what should concern us are not the actual robots, but rather the machines of which both robots and the anxieties generated around them are equally a product" (53); Heidegger's *Ge-stell*; Gehlen's "institution"; not "some lack of humanity" should concern us, "but rather how robots can help us recognise our own machinic nature, and in particular our own roles in the social machine that constructs both the robots and the anxieties around them. [...] it is the machines in our own heads, and not the robots themselves, that are at issue" (53); but: Turing test / Turing maschine (state); Gotthard Günther, "zweite Maschine"; Lacan; David Savat, Uncoding the Digital. Technology, Subjectivity and Action in the Control Society, New York (Palgrave Macmillan) 2013

- technical apparatus (like the ghostly presence of the dead, incorporated in the wax cylinders of Edison's phonograph) questioning the line dividing humans from nonhumans, the creature from the inanimate, physical nature from physical mechanisms. Such distinctions kept cultural self-awareness going but became increasingly blurred through the development of advanced technological systems

- "Not the external and physical alone is now managed by machinery, but the internal and spiritual also" = Thomas Carlyle, Signs of the Times, in: G. B. Tennyson (ed.), A Carlyle Reader: Selections from the Writings of Thomas Carlyle, New York (Cambridge University Press) 1984, 35. "If a machine be defined more or less in accord with the classic definition of Reuleaux, as a combination of resistant parts, each specialised in function, operating under human control, to transmit motion and to perform work, then the labour

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557Report in *Leipziger Illustrierte* from 1878, quoted in: Herbert Haffner, "His Master's Voice". Die Geschichte der Schallplatte, Berlin 2011, 20

machine was a real machine: all the more because its component parts, though composed of human bone, nerve, and muscle, were reduced to their bare mechanical elements and rigidly restricted to the performance of their mechanical tasks" = Lewis Mumford, The Monastery and the Clock, in: D. L. Miller (ed.), Lewis Mumford Reader, Athens (University of Georgia Press) 1995, 315-16; Savat / Chau, 61: Deleuze's / Guattari's "recognition that any machine is first and foremost social"; 65: "social robots especially help us recognise our own machinic nature, and help us recognise that we precisely arrange ourselves as assemblages"; 66: movie *Blade Runner* (Dir. Ridley Scott, Warner Bros, 1982): Tyrrell, whose corporation produces androids, proclaims: "Commerce is our goal here [...]. More human than human is our motto"

The operative presence of technological artefacts from the past

- media archaeological focus on the *operative being* of technological artefacts; only here that artistic materialities deserve to be called *medium* in the sense of information engineering; Paddy Scannell's book *Television and the Meaning of Life* (Cambridge 2014) is an up-date of Heidegger's philosophy of artefactual tempor(e)ality. Heidegger's ontological distinction between beings (things) and their beeing. The use of the hammer; only in its accidental failing the tool becomes apparent as such: Heidegger 1927/1962: 98; *vorhanden* is the distant observation / measuring of the object; *zuhanden* is its "handy" use: "I know what a hammer is by using it properly" = Scannell 2014: 60, hammering is *operative* ontology - a "thing-for-use"; technological configurations are *media* only when being in operation; Scannell 2014: chap. 5 "Turning on the TV set", 60-77

- ancient electro-magnetic telegraphy relay; to what degree "digital" communication not only comes after but actually preceeded the time of analog telephony and radio

- media art preservation a combination of a media archaeological artefacts collection with the signal laboratory, resulting in the concept of an operative media theatre with its core theoretical assumption that a technological artefact is in its medium state only when it dramatically unfolds in signal transmission, recording and replay, or in digital symbol processing

- time-based character of both theatre / drama and the von-Neumann-computer architecture which links both; transform this into experimental performances which (re-)translates the sublime data processing in machines (otherwise unrecognizable for slow human senses) into three-dimensional, audio-visual space

- "antique" technological items not primarily presented as objects from the past but in their presence as "time objects" (Edmund Husserl), not as frozen pieces of hardware shelved in vitrines, but focus the visitors' attention towards the inside and the function of the objects; "open source" and "open access" meant literally here, with a hands-on bias

- early computer game cassette tape identical with audio cassettes familiar from popular music industry in the 1980s. Only when operated in combination

with an early home computer it reveals its meaning as binary data storage for a video game.

- ancient Wire Recorder appearing like the dead end of a technological artefact. But when restored to operation, all of the sudden the recording of oral poetry from the early 1950s (see Albert Lord, *The Singer of* Tales) or vocal testimony from post-World-War II refugee camps (see Boder, *I did not interview the dead)* might resound from the wire spool.

- magnetic core memory grids essential in early electronic computing to keep data for storage in a non-volatile way. It takes operative analysis to decode this message. Such an artefact, may be read out algorithmically to reveal its latent information after 40 years. Delayed memory of such kind is not historical but embodies a different kind of tempor(e)ality

- different from other archival records, technological diagram not historically distant but allows for re-generative experience of a past as presence - such as a musical tone or electrified voice; fig.: Alexander Graham Bell's circuit diagramm for a tune fork telephone

- in terms of historical research, meaning of a past material object in the information attached to it in the form of associated textual records[558]; media archaeology dealing with objects which can be reenacted by virtue of their own inherent techno-logics, momentarily un-doing the "cultural history" gap

- re-enactment of "obsolete" electronic circuitry by operative diagrammatic reasoning; techno-mathematical ratio electronically unfolding again as arche- or genotype, not simply historically distant. In electro-acoustics, harmonic oscillations, by virtue of the medium specifity of mechanical or electro-magnetic vibrations, still behave the same; the present can share the original experience

- Heinrich Hertz' late 19th century experimental setting of wireless "radio" spark transmission in the lecture room of Karlsruhe Technical University; can still be rehearsed and still behaves the same. Media operativity allows for time-tunnelling which is well known from human experimental archaeology; all the difference is the active agency when it comes to *media* archaeological artefacts

- escapement-driven mechanical clocks since late medieval times though liberated oscillations from the impulse of the human hand; electric circuitry since nineteenth century enabled the resonant circuit which is essential for generating non-material oscillations and for receiving electro-magnetic waves.

Re-enacting logical machines

- Heidegger, "Altertümer im Museum". "An artifact is something that happened in the past, but, unlike other historical events, it continues to exist in our own

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558 See David Crowther, Archaeology, Material Culture and Museums, in: Susan M. Pearce (ed.), Museum Studies in Material Culture, London 1988, pp. 35-46 (esp. p. 42)

time. Artifacts constitute the only class of historical events, that occurred in the past but survive into the present. They can be re-experienced: they are authentic, primary, historical material available for first-hand study. Artifacts are historical evidence" = Jules David Prown, The Truth of Material Culture: History or Fiction, in: Steven Lubar / W. David Kingery (eds.), History from Things. Essays on Material Culture, Washington / London (Smithsonian Institution Press) 1993, 3 - though rather media-archaeological than "historical", since historical discourse is bound to textual, narrative historiography. Against a "textual" reading of artifacts, a material techno-logical configuration is non-discursive, non-narrative

- "Reverse ingineering of past techniques provides a way to 'fill in the gaps' in the text. It can also substitute for the text when 'technological processes cannot be adequately described with words [...].'" = xxx, "Reconstructions, Historical and Otherwise", in: xxx

- digital photography ideally (if not practically) "eternal; it is not subject to entropy, to the second principle of thermodynamics."[559] But "[a]lthough digital information is theoretically invulnerable to the ravages of time, the physical media on which it is stored are far from eternal."[560]

- computational media definition not primarily the technology but formats; former technical media like television or radio or the book become formats to be perceived on the computer screen; behind them is the software which defines these objects and enables old media to re-entry the digital sphere; underlying software therefore a cultural document of our time, but how to a) preserve software, b) how does museology put software on display?

- source-code based media art as software "eternal" in the techno-*logical* (Platonic) sense: "Software does not wear out or break down in the traditional sense. Once a software-based system is working, it *should* work forever (or at least until the underlying hardware breaks down [...]. Any latent 'bugs' subsequently revealed in the system are considere flaws in the original design or implementation [...]" = Nathan Ensmenger, Software as History Embodied, Editorial in: IEEE Annals of the History of Computing (2009), 86 and 88 (88)

- to what extent the archival record (document) depending on its material medium (monumentality); symbolical code can be transmitted (now "migrated") with a high degree of fidelity in copying, regardless the material support. Thus the symbolic code (like the genetic code), esp. in the alphabet, is mostly invariant towards historical, i. e. entropical time. Digital *bits*, as informational units, *per definitionem* (Norbert Wiener) are neither matter nor energy dependent[561]

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559 Vilém Flusser, The Photograph as Post-Industrial Object. An Essay on the Ontological Standing of Photographs. In: Leonardo 19 (4), S. 329–332 (331)

560 Jeff Rothenberg, Ensuring the Longevity of Digital Documents, in: Scientific American, Vol. 272, No. 1 (January 1995), 42–47 (42)

561 See Rudolf Gschwind / Lukas Rotenthaler (interviewed by Ute Holl), Migration der Daten, Analyse der Bilder, Persistente Archive, in: Zeitschrift für Medienwissenschaft vol. 2, no. 1 (2010), 103-111 (104)

- "The quality of the medium is of secondary importance, as long as the 'code' can still be decoded."[562] From that results a rather ahistoric form of tradition, different from the scratchy audio signal as phonographic record or the "stealthy disintegration due to the relatively low stability of photographic material"[563].

- documentary science, notion of "logical preservation"[564]. But any information must take place in or on a material support (storage medium), which introduces another, different tempor(e)ality: entropy. "*Prentice Hall's Illustrated Dictionary of Computing* (Nader 1992: 412) irreversibly severs the material link by noting that 'software is independent of the carrier used for transport'."[565] But the metonomy which takes the Floppy Disc as a material support for the software itself is itself a hint to the material link. If past information is not just symbolically emulated but simulated, its temporal (entropic) behavior must be archivized as well - like the scratch, the noise of an ancient Edison phonographic cylinder when being digitized. One method is known from computing as physical modelling.

- epistemological difference between material degradation to the new phenomenon of obsolescence of multi-media data formats; well-known danger to cultural goods, physical entropy, in the logial sphere replaced by a flat tempo(e)ality which is rather a logical state than a temporal ("thermic") object

The ahistoricity of computer architecture

- digital computer essentially a "paper machine" (Turing 1937); possibility to disentangle code from the hardware needed to process it, just as, with musical scores or literature, the performance of playing or reading re-enacts the symbolic instructions. Is the a-historicity of performed code, or of performed music, coherent with the a-historicity Ricoeur sees in the written text when it is actualized through the performative act of reading? Computation is logical and mathematic in essence, so when a new computer emulates an old computer's video game, it actually functionally embodies that old computer during the actualization process. Still it is far slower or faster than the obsolescence-driven hardware that originally supported their existence; preservation should not concentrate on the code only (the "literary" work) whose instructions are perhaps the only time-resisting matter of computer art's "two bodies". Some programming languages may become more obscure than others, but an instruction book on a programming language is also symbolic based, hence time-resistant, work. In Washington, the Library of Congress early movies *paper print* archive preserves early films that can now be restituted, re-enacted, re-animated - like information from the optical images of flat digital

562 Rudolf Gschwind, Digitisation and Long Term Archival of Digital Data, in: Lioba Reddeker (ed.), Gegenwart dokumentieren / Archiving the Present, Vienna (Eigenverlag basis wien) 2006, 183-195 (185)
563 Gschwind 2006: 183
564 Hans-Joergen Marker, Data Conservation at a Traditional Data Archive, in: Edward Higgs (ed.), History and Electronic Artefacts, Oxford (Clarendon Press) 1998, 294-303 (296)
565 Doron Swade, Preserving Software in an Object-Centered Culture, in: Higgs (ed.) 1998: 195-206 (195)

fossils like an early RAM where bits are indicated by colour. Much of what will be preserved in terms of computer culture from the on-going decades will be actually patent-related (thus "archival"), rolls of code printed on paper for copyright purposes still in libraries, hundreds of years after the electro-magnetic supports on which they were created are lost; task of a library or archive, in art museums: physically located bitstream on the storage medium must be preserved as *raw images* for future analysis[566]

How to exhibit computational machines?

- software, considered as cultural artefact, not a material object any more, rather an executable file which unfolds only when being processed (a truly processual time-object). This pushes the possibilities of museum display to its limits. A computer as hardware can be traditionally displayed as an immobile object, but its time-critical and „bit-critical" processes are never in *stasis*, just like frequency-based acoustics (sonic evidence in museums) needs performance in time to take place. With the electronic image, this extends even to visual evidence

- time-criticality a feature of media-archaeological analysis which does not simply media-philologically read source code but focuses on the (f)actually (technomathematically) implemented algorithms

- "What does 'break' over time is the larger context of use"[567], its adaption to new needs, its implemention into the historical context. Coded electric pulses is very immaterial, you can not touch software as such. This is a big challenge for the traditional object/artefact orientated museum

- past design for a media (art) piece time-delayed being realized in the present. Charles Babbage's detailed circuit diagram of Difference Engine no. 2 remained unrealized since 1849, as a paper machine, in latency, as Babbage commented: "The drawings are nearly finished, and the mechanical notation of the whole, recording every motion of which it is susceptible, is completed."[568] But Babbage himself designed a "symbolic notation for his calculating machines which could be diagramatically "run" (tested): a kind of crude emulation, known from cybernetics (block diagram of feedback systems). This concept of diagrammatic timing allows for the transmission within the time channel as well. On occasion of Babbage's 200th birthday in 1991, at least the arithmetische unit has been belatedly constructed in the London Science Museum - "a modern original of an old design", writes Doron Swade, the then curator of the Computer Department.[569] "Capturing the operational persona of an early machines on a latter machine" = Swade 1992: 209 allows to unfold

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566 Thorsten Ries, Die Geräte klüger als Ihre Besitzer. Philologische Durchblicke hinter die Schreibszene des Graphical User Interface, in: Editio 24/2010, 149–199 (155)
567 Swade 1998: 195
568 Quoted here after Bowden (ed.) 1971: 342 (Appendix)
569 Doron Swade, Virtual Objects - Threat or Salvation?, in: S. Lindquist / M. Hedin / U. Larsson (eds.), Museums of Modern Science, Canton, Mass. (Science History Publications) 2000, 139-147 (142)

potentialities which were not even realized in the original machine - which is the essential bias of retro-computing ("past-in-the-future").

- logical machines, unlike energetic machines, less dependent on historical time: "Logical simulation as a virtual object in some respects survives the forensic test of historical utility."[570]

- techno-logical piece inherited from the past becoming a piece of *futurum exactum*: "The logical replica embodies an inexhaustible set of predicates and can be interrogated in the light of unforseen enquiry in ways that physical replica cannot."[571] Swade, with this ahistoric hermeneutics of the machine (since the diagram transcends the boundaries of the historical context), refers to the Turing machine concept itself. Different from other high-technological media, "Turing [...] argued that what defined a computer was not the medium of its physical implementation but the logical rules that define it", and "[...] the identity of a computer is not exclusive to its physical hardware, which may be regarded as accidental to existence but is at least partly, if not wholly, owned by the logical rules that define its operation."[572]

- different from an "action" painting by Pollock, a piece of computer art not uniquely bound to its actual physical implementation. When the core operation of computational art is algorithmic, the source code is the "virtual" body of the actual embodiment - a dynamic variance of the Elisabethan political fiction of "the king's two bodies" (Kantorowicz)

- physical and logical laws of material media suspended from relativistic cultural historicism. At the same time, techno-logical knowledge has to be materially implemented as "hardware" in order to become media-active; this implementation embeds the process in a temporal context with its proper "historical index" (Walter Benjamin).

- in media archaeological terms, radically different preservation strategies for electronic art and computer art. Both have "two bodies": the electro-physical one, and the circuit design / logical block diagram. Contrary to analog electronic devices like radio and video, the computer is essentially logic, therefore the preservation of the logical design is mandatory, while for analog electronics such as video art, signal processing is a direct function of its hardware

- while museum of cultural and technological history successfully presenting a mechanical object such as an early telescope, even if it is broken and mutilated, software collections "imply a functionally intact copy with the promise or potential of running it"[573] to fulfill its "enunciative function" (a term from Foucault's *Archaeology of Knowledge*) since software belongs to

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570 Swade 2000: 146
571 Swade 2000: 144. See as well Klaus Wohlfarth, Zur Rekonstruktion der Z3, in: Wissenschaftliches Jahrbuch 1992/93, Deutsches Museum München 1993, 205 ff.
572 Swade 2000: 146
573 Doron Swade, Collecting Software: Preserving Information in an Object-Centred Culture, in: History and Computing Vol. 4 No 3 (1992), 206-210 (208)

propositional logics itself; "mode of existence" (Gilbert Simondon) of computational algorithms necessarily unfolds in its operational vectors only. Functional intactness in *archived* program software (only the archive or the archive-library ensures the possibility for unforseen future enquiries - which is the condition to generate newness from old records, that is: *information*) demands the ongoing maintenance of "bit-perfect records" = Swade 1992: 209 and compatibility with the original hardware - unless this is itself emulated in logical (as distinct from physical) replication, that is: became software itself (a *mise-en-abîme*), maintaining even the original execution times, which is: the *aura* of implemented and running software as *time object*. For a future historian, it is not sufficient to just re-create the "feel" of an early computer game; it rather has to be inherently authentic, even on the subliminal level below human perception (the "formal materiality" as defined my Kirschenbaum[574]); emulators "mimic the behaviour of hardware"[575], but true *mimesis* co-originary (in a temporal sense beyond "history")

- contextual metadata recorded in unspaced bitstreams; a way to mark the difference in out-reading the data. "Computer scientists call the solution to such a recursive problem a *bootstrap* which provides "some context, which humans can read, that explains how to interpret the digital storage medium."[576]

- *different* from the familiar material artefact in museums, digital media artefacts in a dialectical synthesis combining what has been separated so far between historical and archaeological sciences: textual code and materiality. Since in its most literal sense techno/logy means first of all logical (mathematical, diagrammatical) knowledge which can be symbolically coded as "software" and thus be transmitted across time almost without loss through re-enacment. Any coding is an act of encryption. The risk is known from Bletchley Park where the British intelligence tried to decipher the German Enigma coding of wireless telegraphy messages: Any encryption makes it difficult (and in time-critical terms) even "impossible to recover the original bit stream without the decryption key"[577]. It has been a cryptographer (Ventris) who finally deciphered Linear B writing from Bronze age Greece.

- different from the familiar archaeological artefact, digital documents primarily consisting of a non-material, non-energetic, rather informational (Wiener) essence: a binary, logical object structure, which can be dissociated from the actual material data carrier and can be losslessly copied, transmitted and stored[578] - since the computer is not simply a mathematization of a material mechanism and thus strictly dependent on a specific apparatus like previous media technologies (the phonograph, electronic television), but in a dramatic epistemological rupture born from mathematical theory (Turing's "universal" symbol-manipulating machine 1936/37), a radical mechanization of mathematics

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574 Kirschenbaum 2008: 34
575 Rothenberg 1995: 47
576 Rothenberg 1995: 44
577 Rothenberg 1995: 47
578 Thorsten Ries, Die Geräte klüger als Ihre Besitzer. Philologische Durchblicke hinter die Schreibszene des Graphical User Interface, in: Editio 24 (2010), 149–199 (153)

- in algorithmic coding the task to be performed developed into a time series; in order to be executable, any algorithm has to take place in matter - even if this is just numbers and letters on paper, written and read by humans (the Turing machine)

- so-called Mechanism of Antikythera from late Hellenistic times, even if corroded to an almost entropic mass of metal, still remodelled by Derek de Solla Price.[579] Experimental archaeology of material cultural knowledge oscillates between implicit (latent) knowledge in terms of physical and mathematical self-evidence and "tacit knowledge" (Polanyi's undocumented social skills / *techné*)

Operative "dead" media collections

- for techno-epistemological analysis of media art, emphasis not on the phenomenology of user-interaction but on the material artefact, its media-art(e)factuality, encompassing the materiality of both analog and digital media for cultural tradition, and software as new objects of knowledge transmission and as a challenge to museum-like conservation

- imperative for *operatitive* preservation of media-archaeologically relevant objects (as argued by Peter Donhauser, Technical Museum Vienna, for his operative re-creation of the historic Bechtstein electronic piano, or Doron Swade, when curator of the computing department in the Science Museum, London, on the museological challenge of "preserving software")

- objects whose main function is processuality (both material and algorithmical), as *archive in motion* (Rossaak) requiring a dynamic preservation museology

- methodology of "operationality". If the cultural and discursive knowledge of media is not meant to be limited to images (in texts and books), to distant observation (in museums) and to pure documentation (in archives), there is a need for real places and digital platforms where technical objects can be confronted in their primary materiality and virtual operativity. Analysis here means actually or symbolically opening the "black box" to get insight into what media do. For analog technologies this means actual disassembly; for software-driven media this means to get acquainted with programming languages like Assembly (close to the machine). This means expanding further from representational approaches towards the idea of operationality of the devices in collections. Hence through operationality, the focus of the archival work turns from the normal function of preservation to issues of technological education, theoretical inquiry and artistic practice; counter-strategy to "black boxing" design strategies of modern technical media; expand the usual archival or museum functions concerning cultural heritage of technology and scientific apparatuses

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579 See Tony Freeth, The Antikythera Mechanism. Decoding an Ancient Greek Mystery (exhibition brochure), Whipple Museum of the History of Science, University of Cambridge, England, 2008

- practices of disassembling and reassembling becoming integrated as part of the activity of the operational media archaeology labs

- technical objects in "media" state / being only when implemented in operation. In a comparison with traditional practices of media-historical display (with representatives from museums, archives and collections), the specific need for an operative assemblage of technical objects in the context of cultural and academic teaching and research shall be outlined - both for the epoch of analog and of digital media. The specific "triad" of Media Archaeological Fund (the presence of artefacts), Signal Laboratory (digital signal processing), and Media Theatre (machinic-operations confronted to human performance) provides for a model of operative media analysis

The temporal challenge of Internet art

- genuine, medium-specific (and not just content-oriented) Internet art from an error: "In December 1995 Vuk Cosic got a message, sent via anonymous mailer. Because of incompability of software, the opened text appeared to be practically unreadable ascii abracadabra. The only fragment of it that made sense looked something like: {...]J8~g#\;Net.Art [...]" = Alexej Shulgin, Nettime, quoted in Galloway 2004, motto to chap. 7 "Internet Art"

- Cosic interested in ASCII code during research "on low-tech aesthetics, the economy, ecology and archaeology of the media, on the intersections between text and computer code, on the use of spaces in information, its fluid nature and infinite convertibility. Out of this came [...] Deep ASCII and ASCII History of Moving Images, a history of the cinema converted into text format" = https://en.wikipedia.org/wiki/Vuk_%C4%86osi%C4%87 (accessed January 16, 2017); created File Extinguisher, an online service that allows to delete files with absolute certainty; http://www.ljudmila.org/~vuk/ascii/film

- Galloway 2004: 217: the 404 error code, used by artist Lisa Jevbratt's *Non-Site Gallery*. Since 1995, in early explicit *net.art* (including, f. e., Jodi) , the medium is the message - like every first, media-archaeological technologically self-reflexive media art (video), "is concerned primarily with the net/work, while later Internet art [...] has been concerned promarily with software." = Galloway 2004: 218 f. "As computers and network bandwidth improivged during the late 1990s, the porimary phsical reality that governed the aestehetic space of net.art began to fall away" = Galloway 2004: 220; the shift from media-archaeological aesthetics to content.

- Swiss initiative *Aktive Archive* (www.aktivearchive.ch) dedicated to preserving so-called "instabile media", symbolically re-enacting even an online-art work on flash-based dynamics as CD = Vera Kuni, in: Müller / Scheidgen (eds.) 2007, 312; Variable Media Network www.variablemedia.net

- in theory, no "digital decay"; Boltzmann-entropy differing from Shannon-entropy; option to chisel zeros and one or whole web-sites in stone like an ancient epigraph, as has been drastically performed by Joachim Blank /

Karlheinz Jeron 1999 in the exhibition *net_condition* for Natalie Bookchin's and Alexej Shulgin's *Introduction to net.art* (1994-1999)[580]

- erasing records; artists created artificial information deserts and voids in cyberspace indeed, such as Mark Napier (New York) with his project *The Landfill*, turning any content of web-pages into graphical raw material. But such aesthetic interfaces hide the digital truth behind the simulacra. The more radical version is the cookie (micro-program) *ArchiVirus* created by Manu Luksch, Arnim Medosch and R. Steckel (to be copied from the internet on one´s own computer) which decomposes textual documents on the hard disk into its ingredients; alphabetically sorted, all the letters of a file appear on the screen, sense-less, but as a kind of raw material for composing new texts

- crucial difference between media art which is simply represented, indexed and mapped online, and the Internet itself as the material for artistic work, like art produced in HTML code itself, using ASCII-symbols of the source code of homepages (as has been done by the artists Blank & Jeron (Jodi)[581]

- Vera Kuni differentiating between technical emulation and "conceptual" emulation = 2007: 311, resulting in a re-creation while preserving the original concept - the diagrammatic preservation of media art

- what had been the cultural-historical "context" for previous art works, today replaced by a techno-media ecology as Internet browser "environment" - consisting of plug.Ins and image, text or sound formats (un/compressed) like .jpg, .mov

- Jodi's ASCII art displaying raw source code itself. "No other style of net.art reflects so directly on the nature of the Web as medium." = Galloway 2004: 220

- conservation of new media art challenged by the the obsolescence of digital technology accelerating in ever smaller intervals. The planned ephemerality of Fluxus (video) art (Nam June Paik; Wolf Vostell) unintentionally correlates, in the analog signal domain, with the ephemerality of Internet art in the algorithmic domain

- http://newmedia.umaine.edu/interarchive/three_threats.html: a dynamically generated synopsis of the site 'Three Threats to the Survival of New Media' in printable form; the interactive version at http://newmedia.umaine.edu/interarchive/three_threats.html

- "The centralized storage strategy that has served as the default preservation paradigm for culture in the 18th through 20th centuries will utterly fail as the preservation paradigm for the 21st. Archivists specialize in keeping the works in their care as static as possible, but new media survive by remaining as

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580 See www.easylife,org/netart; catalogue: Timothy Druckrey / Peter Weibel (eds.), net condition, Camrbidge, Mass. 2000
581 See Inke Arns, "Unformatierter ASCII-Text sieht ziemlich gut aus". Die Geburt der Netzkunst aus dem Geiste des Unfalls, in: Kunstforum International vol. 155, 236-242

mutable as possible

- archaic work no longer functioning with current browsers; most external links expired; no more interface for storage medium; demagnetization

- remaking "variable media" from archived screenshot evidence and few of textual records, vs. emulation, as functional re(non-)interpretation; different from reenactment of historical events by amateur actors

- term "archive" frequently applied to cultural memory institutions such as traditional musums and libraries. But in this media alliance, culture should not be thought of by de-differentiating its storage media. The notion and the institution of the archive dissolves in(to) the Internet. Let us mention, f. e., the HILUS intermedial "Informationssystem Kunst + Neue Technologien" (based in Vienna). An advertizing postcard
declares three sections: "*ARCHIV*/Bibliothek, *ARCHIV*/Videothek, *ARCHIV*/CD-Rom-Sammlung". HILUS Intermediale Projektforschung beendete seine Tätigkeit mit dem 31.12.1996; http://thing.at/hilus/server2.htm (1992-1996)

- will the future experience these works as physical traces (hardware) or rather as coded documentation, or in its dialectiv synthesis which is emulated media artifacts

- radical change in the engineering of cultural tradition with the digitization of analogue (signal-based) audio-visual media art archives (sound art, video)

- http://www.archive.org aware of the accelerating obsolescence of media art Web pages in the Internet; it provides for a symbolic time machine: the so-called Wayback Maschine. For an Internet address (URL) it presents a chronologically ordered list of links to the same web page at different times

- "The Internet Engineering Task Force develops "technical standards that give a unique identification name to digital documents. These uniform resource names (URNs) <...> could supplement the URLs that currently access Web documents. Giving a document a URN attempts to ensure that it can be traced after a link disapears."[582]

- collecting principle of the museum and storage principle of
computing belonging to different eras, even if they co-exist in the present. For dynamically generated web content of the Internet, no archive (the "dark web")

- *Permanence Through Change: The Variable Media Approach*;
http://www.variablemedia.net/e/preserving/html/var_pub_index.html

- media-archaeological imperative to preserve the technological message of media art, not only its aesthetic content. "Marshall McLuhan once claimed that the medium is the message. Replace medium with format. How far does it hold true? And how much may we permissibly change the message on oder to give access to it, in a newer format, say, or over the Internet?" = Ray Edmondson,

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582 Brewster Kahle 1997: 83

AV archiving philosophy - the technical dimension, in: Proceedings of the IAMI-IASA Joint Anjual Conference, Perugia 1996, xxx no. 8 (November 1996), 28-35 (29). "Marshall McLuhan once claimed that the medium is the message. Replace medium with format. <...> Whenever content is moved from one format to another, *what is lost or chanced* and *does it* matter?"[583]

Towards the dynamic "archive"? Rhizome ArtBase (since 1999)

- EAS emulator service

- ISO file an "image" of a CD/DVD; using a burning program like Nero, or ImgBurn, to burn that ISO file directly to a disk; Tim Fisher, updated October 20, 2016; "single file that's a perfect representation of an entire CD, DVD, or BD. The entire contents of a disc can be precisely duplicated in a single ISO file. Think of an ISO file like a box that holds all the parts to something that needs built - like a child's toy you might buy that requires assembly. The box that the toy pieces come in does you no good as an actual toy but the contents inside of it, once taken out and put together, become what you're actually wanting to use" = https://www.lifewire.com/iso-file-2625923, accessed 24 March, 2017

" e. g. image of Operating System MAC OS 9, put onto an emulator; accompanied by "delta file" to record just the modifications

- taking care of migration of emulators, instead of migrating every single web art work content; EML (emulator); Rhizome strategic decision: concentrate on art works based on custum computer software / OS / browser, unequal independent media (archaeological) art from scratch

- "Webrecorder" (free software, deposited on GutHub) allowing for "archiving" one's personal encounter with the Web / symmetrical web archiving; recording of interaction with the web-site within one browser / record traffic between browser intalled on PC and Internet, as "performative archiving"

- moving image portals like Like YouTube; Internet itself the dynamic library of performative media art, autopoetically prolonging its tradition by countless data file copying and mirroring the operating system; when the technical, infra-structural context expires, the records will expire as well

- digital culture aware that there is no work for eternity any more, resulting in the preemptive archival perspective of *futurum exactum* for ephemeral technologies like software code, websites, moving images and sound, interactive games, and browsers. Since contemporary computers are mostly unable to "perform" many of the artworks as they were originally experienced, the Rhizome initiative in New York City (in affiliation with the New Museum of Contemporary Art) started its Digital Preservation program so that net art works from the recent but technologically dis-continued past may be reperformed in their media-environmental context, with an emphasis on providing contemporary users "a sense of their initial form" URL ??? - which is the phenomenological, human-oriented approach to preservation of media art;

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583 George Boston, lecture at IAMI/IASA Joint Annual Conference, Perugia 1996

media-archaeological alternative sets priority on the preservation of the underlying technology which is the generative grammar of "aesthetic knowledge" behind (genotypal rather than phenotypal)

- Rhizome's ArtBase less an online archive but collection of born-digital art (net art works and other forms of projects with online elements). Its primary task is up-dating obsolete code. As a challenge to inherited museum authority for cultural heritage preservation, its focus is on the development of open source web tools "to decentralize web archiving and software preservation practices" = https://en.wikipedia.org/wiki/Rhizome_(organization), accessed March 13, 2017; ensure continuing access; conceptually, *open source* does not simply mean the media-political for open domain, but to reveal its algorithmic structures. Rhizome launches social media "archiving" tool Colloq which replicates the interface of social media platforms - once more, the phenomenological appeal is given priority, by re-generating its operating systems. Even if the inside of the algorithmic machine is the pre-condition for such sensual preservation, the emphasis is not on its insight. In its media-phenomenological orientation, "Colloq pays special attention to the way a user interacts with the social media interface at the time of creation, using a technique called 'web capturing' to store website behaviors" = ibid.. For the art blog VVORK, Colloq used to archive the entire website. "Archiving VVORK allowed Rhizome to tackle the challenge of archiving embedded video content, which is often hosted on a third-party site" = ibid., different from the limit of the Wayback Machine to non-dynamic objects: website previously archived by Internet Archive, "but this recording did not include embedded media like videos that Colloq was built to capture" = ibid.; Jon Ippolito: "you're going to get the experience of interacting with the actual site" = quoted ibid.; performative *historical re-enactment* rather than operational techno-archival display

- since 2016, Webrecorder tool as free web archiving tool "allows users to create their own archives of the dynamic web" = ibid., rather than static webpages; classic archival terminology starts to be misleading, demanding replacement by a more "born-digital" terminology of such storage such as *embedded software*. Web 2.0 trans-archival ethics (like social tagging in virtual museology) is is an attempt to place web preservation tools in the hands of individual users. Web historicism: "It uses a 'symmetrical web archiving' approach, meaning the same software is used to record and play back the website. Webrecorder actually records users "browsing the site to capture its interactive features" = ibid.

- Rhizome's oldweb.today project; view archived webpages within emulated versions of legacy web browsers - dissimulating the contemporary Internet itself; new media historicism: project gives users a "deeper understanding of web history"; browsing environments alter one's experience of the internet. "It is an example of 'Emulation as a Service' technology, imitating old software programs so that they can run on new computers" = ibid.. This aks for a media-archaeologically reminder of the metahistorical theory of computing itself: New computers with the very symbolical recoding of obsolete computer hardware are still based on the Universal Turing machine model - which deserves to be placed into the center of discussing digital media art preservation, and to path

a way through the growing confusion of key terminology ranging from "updating", "preserving", "reenacting", "archiving" to "restaging"

Archival need for re-operative hardware (or its emulation): U.S. Census files

- for compilation of decennial population census in the early sixties, U. S. Census Bureau retaining records in what it regarded as permanent storage. "In 1976, the National Archives identified seven series of aggregated data from the 1960 Census files as having long-term historical value" - which is the archival decision. "A large portion of the selected records, however, resided on tapes that the Bureau could read only with a UNIVAC type II-A tape drive. By the mid-seventies, that particular tape drive was long obsolete, and the Census Bureau faced a significant engineering challenge in preserving the data from the UNIVAC type II-A tapes. By 1979, the Bureau had successfully copied onto industry-standard tapes nearly all the data judged then to have long-term value" = "http://lyra.rlg.org/ArchTF/tfadi.intro.htm#fragility; data rescuing challenge a signal event; moved Committee on the Records of Government six years later to proclaim that "the United States is in danger of losing its memory"; when computer tapes containing the raw data from the 1960 federal census came to National Archives and Records Service, only two machines operative for reading those tapes: one in Japan "and the other already deposited in the Smithsonian as a relic" = Committee on the Records of Government 1985:9, 86-87)

Really "forensic" media archaeology of an "archive" (the ROM)

- double task in museological preservation of media art: not just preserving the aesthetic content but its cultural memory of the technological "condition of possibility" (Immanuel Kant) as well which made "media art" possible as art form in 20th / 21st century at all; artistic and aesthetic phenomena arising from a piece of media art mostly dissimulate their conditional techno-mathematical processing; "forensic" and "formal materialism" (in Kirschenbaum's sense) analyzes the critical techno-logical layers underneath, that is: the structure of its logical circuits and its digital codes. A media-archaeological understanding of early computer art is not nostalgic but has a techno-mathematical cutting edge, detecting.

- reading out the bits which are magnetically latent in a ROM; this code then put through the MAME *disassembler* and the remaining unknown bits figure out to make good code[584]

- microchips and codes (hardware and software) both requiring analytic hacking (media art "criticism"). Software hacking is dangerous on the symbolical level, while tinkering with circuits that are directly connected to mains electricity is dangerous in a physical sense

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584 See "Fun with masked ROM / Atmel MARC4", http://adamsblog.aperturelabs.com/2013/01/fun-with-masked-roms.html; accessed July 10th, 2014

- if algorithmic documentation lost, material criticism required, "[...] trying to do something like reset a fuse to allow reading/writing of protected areas or probe a data track to observe data being processed by the chip, or even trying to figure out the actual logic of a proprietary chip by viewing and reverse engineering it's construction"

- specific media-archaeological (or media-archival) target: the program code that is stored in a masked Read Only Memory (ROM) chip; if chip itself is using a known architecture and a known assembly language, "the only reverse engineering required is to recover the actual instructions stored in the ROM"; "forensic" philology of a masked RAM chip

- *semantic gap* opening when future observers (users) do not understand interface interaction of a piece of computer art any more

- CD-ROM not keeping its data intact for a long time; machines themselves will become dated and be replaced by other systems in faster rhythms; therefore museum of algorithms is required.[585] If we consider the museum in terms of its traditional content which differentiates it from the library and the archive is the collection of material artefacts), these objects are surprisingly enduring. This quality should not be lost when museums are trying to be "digital" themselves. The discussion of the immaterial museum started with photography (André Malraux' *musée imaginaire*); Walter Benjamin was concerned that the photograph-based image collection could not be called "auratic" any more, since the technical reproduction loses the material basis of the traditional work of art. The materiality aspect completely shifts from the tight coupling of carrier (screen) and iconic surface (oil painting) to the electronic or computational image where the materiality is loosely (ephemrally) coupled to its visual signal output.

- "A medium is a large mass of loosely coupled elements, which is susceptible to form. [...] Within a medium, forms mark the difference between loose coupling and tight coupling"[586]; inbetween, coupled elements from different technical epoques, heterochronic (Simondon / Serres)

Re-enactment of *The Speaking Clock*

- several compatability layers (immanent "interfaces") within computers; translates previous operating system requests into the "language" (syntax) of new (WINE);triple stragety: maintaining hardware; emulating operating system to maintain the time-critical (not just logical) behaviour; like printing press: re-

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585 See Doron Swade, Collecting Software: Preserving Information in an Object-Centred Culture, in: History and Computing Vol. 4 No 3 (1992), 206-210; same author, Virtual Objects - Threat or Salvation?, in: S. Lindquist / M. Hedin / U. Larsson (eds.), Museums of Modern Science, Canton, Mass. (Science History Publications) 2000, 139-147
586 Luhmann 1992: 30 f., referring to: Fritz Heider, Thing and Medium, in: Psychological Issues 1.3 (1959), 1-31

create "matrix" for new series of lithographic microprocessors (electronic core devices): embodiment of logics.

- structural architecture of electronic and computational media allowing for a *non-historicist* form of preservation which is the co-originary re-creation of a hard- and software logic instead of the niqueness of its once individual implementation

- preservation of computer not reducable to the "ontology" of the algorithmic archive; loss of the real hardware support of media art (by migrating its data) would make posthumous investigations into the technological *a priori* of its aesthetic phenomena impossible. For historians it is imperative *not* to substitute the original archival record by a high-resolution copy

- John Cayley's poetry generator The Speaking Clock as example of "ergodic art": Espen Aarseth, Aporia and Epiphany in Doom and The Speaking Clock. The Temporality of Ergodic Art, in: Cyberspace Textuality. Computer Technology and Literary Theory. Edited by Mary-Laure Ryan. Bloomington and Indianapolis: Indiana University Press 1999, 31–41

The digital temporalization *versus* the material endurance of architecture

- "architecture" a) physical building materialities and b) structural conditions, the *arché*; known from computing as well which is both symbolical code (software) and physical implementation to actually make it happen (hardware). The very term techno/logy reminds of this split ontology: both the regime of *logos* and of *techné*; "technology" not only the science of *techné* but the *logos* (in terms of algorithms) has been implemented in the material technique itself

- proto-"digital" forms of transmitting architectural information for posterity: Alberti's "digital" transmission (tradition) of architectural urban memory by its radical sampling and quantifying into numbers in a Cartesian grid[587]

- privileged affinity between architectural theory and technological media analysis, resulting in a *virtual museum* in the sense of "computer architecture"

- Harold Innis developing his pre-"media theory" from research into the economical history of Canada such as fur trade; "Carthage paradigm" from a privilege of transmission over storage, or rather: networking (naval trade routes in the case of Carthage), with "nodes" (ports) and *staples* which are intermediary storage; emphasis on transfer, not (imperial) storage; Innis later differentiating between space- and time-"biased" empires; Canada relating to the latter one, the US to the rather space-based Roman Empire, allowing for a direct a-historical short-circuit between Rome and ROM - the name for the imperial order within computing, the Read Only Memory chip

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587 See Mario Carpo, "Descriptio urbis Romae". Ekphrasis geografica e cultura visuale all´alba della rivoluzione tipografica, in: Albertiana, Florenz (Olschki) vol. 1, no. 1 (1998), 111-132

- visualizing Internet data flows / visualizing high frequency e-trade: the *New York Stock Exchange (NYSE) Virtual Trading Floor and the NYSE Command Center designed between 1997 and 1999 by Asymptote Architecture (Hani Rashid and Lise Anne Couture)*; purpose of this virtual environment to visualize real-time numerical and statistical data, detect suspicious trading activity, and track the impact of global news events on the market. "The design's starting point was the existing physical trading floor, including abstracted virtual versions of the circular posts where traders were stationed. The real-time virtual environment returned to the physical world with the design and construction by Asymptote of the Advanced Trading Floor Command Center in the New York Stock Exchange"; high frequency trading, though, asks for a phenomenological interface to reveals its micro-temporal moment, which deserves different forms of becoming visualized or better: sonified, just like earthquake analysis is better done by audification, since the human ear is most attentive to micro-temporal changes (known from music listening)

- every architectural material form "neg-entropic" - while every articulation of "digital" architecture is entropic in the sense of Shannons information theory

- architecture *lasting* (German "lastet") not only in the material but as well in the temporal sense; time as channel; the slowness of "transmission" (storage); technical term from electro-engineering (and radio/antenna) German "erden"

The *a-historical* temporality of virtual reconstructions of architecture

- notorious case of architectural reconstruction with computer-aided means: baroque Frauenkirche cathedral in Dresden collapsed in result of bombing in World War II and since remained a ruinous memorial. What has been called "archaeological reconstruction" by the resposible project leaders has since created the impression of time-reverse against the essential characteristic of historical time which is material entropy (architectural ruins). In Dresden, the so-called "archaeological reconstruction" was in fact a media-archaeological one: supported by IBM calculation, re-configuring the remaining building bricks and stones into the core of the reconstruction.

- "[...] computer-simulated rooms have established links, unities, and coherences wherever the factual state of the collection consists essentially of lacunae. / Now computer simulations may close up these gaps - say, in the famous IBM action of computer-projecting the ruins of the abbey church of Cluny as a virtual reality" = Friedrich Kittler, Museums on the Digital Frontier, in: Thomas Keenan (ed.), The End(s) of the Museum, Barcelona (Fondació Antoni Tápies) 1996, 67-80 (72 f.)

- media anthropology mostly concerned with the phenomena displayed to human senses; parallel reality at work which is hidden to the visitor - to be critically discovered by media archaeology (the algorithmic "subface" as opposed to "interface", in Frieder Nake's terms[588]. Analogous to Lacan's RSI

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588 Frieder Nake, Zeigen, Zeichnen und Zeichen. Der verschwundene
    Lichtgriffel, in: Hans-Dieter Hellige (Hg.), Mensch-Computer-

triad: "[...] it also produces a data record that has never existed before. The ruin, beyond its imaginary completion, is also stored in symbols or algorithms. Each stone, whether preserved or simply presumed, has entered an objective structure" = archi(ve)-structure, "that makes it addressable according to its dimensins and characteristiscs. Each stone is both a fetchable data record an a fetchable procedure of its playback. [...] computer simulations do not merely form user interfaces, they actually constitute a museum. More precisely: a museum that, as in acient Alexandria, also functions as a library that has not gone through the modern split between texts and images, libraries and galleries."[589]

- overall impression of "virtualization", "digital architecture" in its material sense, nowadays a new class of architectural objects: the micro-architectures of computing machinery, as expressed in the literal "von-Neumann architecture" as a term for storage programmability

- "adventure" computer games passing through spaces; each room being calculated as a function of source code; the architectonic signifier a data type like "struct", consisting of diverse "static void" entries and values, archi-texture

- resisting visual metaphors which compare the close-up photography of microchip circuits with the birds-eye view of a urban city

- museology of computer and computing *architectures* an escalation of the exhibition *Les Immatériaux* curated by Jean-François Lyotard at the Centre Pompidou in Paris in 1985; Lyotard conceptually starting from the Indo-European linguistic root *mât* which means both measurement and construction, to unfold the different layers of the material (hardware) but as well the matrix (code) of "New Materials and Creation" (which has been the originally termed title of the exhibition). In spite of the immaterialities suggested by the final title, Lyotard insists that in a real museum exhibition nothing is more materially grounded that the seemingly immaterial objects on display = Jean-François Lytoard, After Six Months of Work ... (1984), in: Hui / Broeckmann (eds.) 2015: 25-66 (26). For an "immaterial" version see www.meson-press.com

- "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 threadds 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" = Paul Virilio, Une vielle surexposée, in: Change International no. 1 (December 1983), 19-22; transl. "The Overexposed City", in: Zone 1-2, New York (Urzone) 1986, 540-550 (545)

Interface. Zur Geschichte und Zukunft der Computerbedienung, Bielefeld (transcript) 2008, 121-154

589 Kittler 1996: 73

- Virilio describing urbanism in a telematic society; finds parallel in computing architecture itself; radical update of the *Immatériaux* exhibition of 1985 will be an equally co-original display of computer architectures from within. Once the time-critical elements becomes essential for the very possibility of "virtual" architural "spaces" to emerge and exist, the term computer is to be replaced by computing, with an emphasis on the processual

- new kind of archival "tectonics"; revelation of computer- and source code architectures itself; switch from computer-based representations of architecture to the architecture of digital computing

- *information architecture* behind the current forms of digital communication and Internet usage, consisting of several layers; such information needs to be archivized since it usually does not enter social and cultural memory on the discursive level

- term "tectonics" known in archival science but will be given a new meaning; online glossary of the Swiss Federal Archives: archive *tectonics* "[d]escribes the hierarchical structure of an archive's holdings. The Swiss Federal Archives contain various description levels: Main Departments (top level), fonds, sub-fonds, series, dossiers and documents (lowest level). The archive plan search in Swiss Archives displays the archive tectonics in a hierarchical tree structure" = http://www.bar.admin.ch/archivgut/00941/01551/index.html?lang=en; access 28th July, 2014

Up-dating "Museums on the Digital Frontier"

- by-gone times when electronic computers themselves were "passable" - not as a didactic metaphor (like the giant computer once exhibited in The Computer Museum at Boston, Massachusetts, opened in 1979 and operated in three different locations until 1999; *inter alia* The Walk-Through Computer, a two-story-high model of a personal computer, simulated to be working interactively;
https://en.wikipedia.org/wiki/The_Computer_Museum,_Boston#The_Walk-Through_Computer_.281990.2C_1995.29, accessed August 21, 2015

- three-dimensional computer (by necessity) can still be experienced *within* the UNIVAC computer in the Deutsches Museum, Munich; in age previous to Integrated Circuits, electronic components still three-dimensional.

- the structure of techno-archives, and not their metaphorical (re-)presentation, which might become the real focus of an architectual museum = Friedrich Kittler's text "Museums on the Digital Frontier", published in: Thomas Keenan (ed.), The End(s) of the Museum, Barcelona (Fundació Antoni Tàpies) 1996, 67-80 (73); open computer architecture: Z1 re-built by Konrad Zuse for Deutsches Technikmuseum, Berlin; Technische Sammlung Dresden: demonstration computer with slowed-down cycles (Lehmann); light bulbs not metaphoric but indexical, embodying sotarge of on bit

Digital Archivetextures

 - histograms in image processing to calculate the entropy value of a (digitized) image

- inbetween the classical museum and the virtual museum as a function of computer simulation of architecture and CAD, the media-archaeological artifact: computers from the early time of electronic and analog computing which where as big as rooms, thereby literally accessible such as the UNIVAC in the German Museum (Deutsches Museum) in Munich into which I have been once allowed to step in

- "launch of the PDP-1 (Programmed Data Processor-1) computer in 1959 marked a radical shift in the philosophy of computer design: it was the first commercial computer that focused on interaction with the user rather than the efficient use of computer cycles" = http://www.computerhistory.org; Zugriff 6-6-08

- less metaphoric "museum space" but navigation as operative diagramm (circuitry itself)

- "algorithm" in the context of computing implicitely referring not to the written code lines (like a musical "score") but to the hardware-implemented, executable algorithm, in computing architecture. In itself, an algorithm is just a mathematical notation which does nothing by itself. It has to be *read* - better by machines (the Turing machine "tape reader") than by capacity-limited and slow human eyes. It has to be implemented into physical matter (the "computer" as artifact) in order to be gifted with time, to become processual in the time axis. The von-Neumann-*architecture* of computing is strictly sequential ("one bit at a time") and can only become *pseudo*-parallel

- concept *Museum of Algorithms*; an understanding of "virtual architecture" resp. "algorithmic design" from its condition of possibility; media-archaeological "layers" of computing architecture; archival / algorithmic "tectonics"; think the digital archive from the computer architecture (both hard- and software; "computer architecture" concerned with how the central processing unit (CPU) acts and how it uses computer memory = Wikipedia

- beyond physical architecture restrains, *n*-dimensionality

- ZKM media art installation *Legible City* by Scott not "legible" any more; re-enactment as problem of the "digital", better: algorithmic archive; Center of Digital Tradition (Codigt) at KIT (Karlsruhe); Gregor Vrachliotis at Faculty for Architecture

- in reverse of architecture becoming digital, the digital (which is a conceptual symbolic tool) becoming "architectural" by its implementation into hardware which brings it into the material world / into physical and informational time; tempor(e)ality of digital works preservation from *within* computing systems