[Wolfgang Ernst: SCRIPTS ON TECHNICAL MEDIA]

TEXT BLOCK "SPACE-VARYING SIGNALS (ICONICITY)"

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Technical Imaging
Algorithmicized Image Retrieval

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"SPACE-VARYING SIGNALS (ICONICITY)"

Technical Imaging:

THE COLD MEDIA-ARCHAEOLOGICAL GAZE: PHOTOGRAPHY

[La tension média-archéologique entre la peinture et la photographie]

Média-historiquement, il y avaient des nouvelles definitions de l'esthétique de l'image par l'indexicalité de la photographie. A ce point, une définition distincte est necessaire: L'euvre de l'art n'est pas un *medium* en sense technologique. Peinture et sculpture sont des techniques culturels - toutes liées au corps humain (les mains, le regard, la procession cognitive). Mais technologie est l'autonomisation des la technique, l'automatisation; un scène fondatrice était la "liberation" des images mondiales du geste humain de la peinture par le procesus kalotypique de la photographie.

Comme dramaturgie, le film *Mr. Turner* (2014) est une récit biographique traditionelle. Mais regardé avec des yeux média-archéologiques, aux même temps, l'apparatus cinématographique reproduit des oeuvres de Turner qui sont *peint* avec couleurs materiaux sur un écran par projection de la lumière aussi sur un écran - l'écran de la cinéma. Un moment décisive dans le film est Turner qui regard une chemin de fer en passant, laissant des nuages de la fumée. Cet argument reste authentiquement plus vivant non-historiquement en reproduction cinématographique.

Dans ce contexte, il faut rendre l'opération archéologique à la France, mais non limité aux analyses de l'auteur Michel Foucault, plutôt au-délá:

comme *média* archéologie. Dans son interpretation des peintures de Edouard Manet[1], Michel Foucault sougligne l'écran plat, mais Foucault était aveugle pour les effets lumineuse de photographie qui étaient implicite ici: l'illumination eléctrique.

Média-archéologiquement, ils emergaient des nouvelles retrospectives sur l'histoire de la peinture par des opération photographiques, comme expliqué par Herman Grimm au fin de siècle dix-neufième pour les études academiques de l'historie de l'art. Le *Skioptikon*, un projeteur des diapositives des peintures historiques, rendrait possible une analyse des oeuvres en détail par agrandissement (le regard média-archéologique) et *comparée* comme condition d'un constallation formaliste de l'art, pas historiquement (limité à la contextualisation par les textes écrites).[2] Dans ce sens, André Malraux dèjà avait identifié un *musée imaginaire* par l'ordre médiatisée: la standardisation des oeuvres de l'art par la photographie noir et blanche.

Technological media (photography) and the *beaux arts*

Cultural artefacts deserve to be differentiated from technological media. Sculpture and painting can *not* be considered as *technical* media. Painting is no technical medium in itself but can be related to technical media.

The direct relation of technologies to art history as research method started with the impact of technical means of reproduction of works of art (engraving, photography, the digital scan). That has become an issue of art historical research already. But a true *media archaeology* of art does *not* start with the obvious impact of photography on hand-related arts like sculpture and painting.

In Clement Greenberg's sense the flat surface of the painterly screen rather becomes the material "message" of the physical "medium". As has been pointed out by Greenberg in his writings on art, modernist painting itself has (re-)discovered the grounding materiality of the rectangular canvas as the principal message. McLuhan developed this insight into a media theory. The historicist idea of art historical moments itself is a photo-realistic effect.

Painting (art work) vs. photography (technical medium)

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1 Michel Foucault, La Peinture de Manet [1971], in: Les Cahiers de la Tunisie, numéro spécial: Foucault en Tunisie, Tunis 1989, 61-87

2 Herman Grimm, Die Umgestaltung der Universitätsvorlesungen über Neuere Kunstgeschichte durch die Anwendung des Skioptikons, in: idem, Beiträge zur Deutschen Culturgeschichte, Berlin (Wilhelm Hertz) 1897, 276-395

Ironically, it has been a painter, Henry Fox Talbot, who In 1844, in the introductory remarks to his publication *The Pencil of Nature*, emphasized that the inserted photographic plates "[...] have been formed or depicted by optical and chemical means alone, and without the aid of any one acquainted with the art of drawing"[3]. By means of his invention of negative-to-positive kallotype photography) radically broke with the art historical and philosophical tradition and aesthetics of *mimesis*, iconological semantics and visual hermeneutics in his almost media-archaeolgical definition of photography: "The picture, divested of the ideas which accompany it, and considered only in its ultimate nature is but a succession, or variety of stronger lights thrown upon one part of the paper, and of deeper shadows on another" (ebd.).

Media archaeology leaves it to art history to investigate the aesthetic impact of photography on human works and rather identifies the epistemological momentum deriving from within photography. "[A] painting, before it is a naked woman, a horse in battle, or an anecdote of some kind, is first a flat surface covered with colored marks assembled in a certain order."[4] John Ruskin defined the painting as "technique", operating on the difference between cognitive aesthetics and perceptual *aisthesis*: "We *see* nothing but flat colours; and it is only by a series of experiments that we find out that a stain of black or grey indicates the dark side of a solid substance, or that a faint hue indicates that the object in which it appears is far away. The whole technical power of painting depends on our recovery of what may be called the *innonence of the eye*."[5] But the human eye, in its cultural education, can never be innocent. To be suspended from iconology, humans may delegate visual analysis to the electric scanner and digital imager. The result is a new, media-archaeological way of looking at paintings from the past. 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 only incidentally visual and auditory; it is primarily tactile"[6] in terms of the electric stroke or impulse.[7] Thereby the world of the symbolic order is implemented in the electro-physical real word.

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[3] Henry Fox Talbot, The Pencil of Nature (London 1844; Reprint New York (DaCapo Press) 1969

[4] Maurice Denise, as quoted in Moles 1968 / 2011: 265

[5] John Ruskin, The Elements of Drawing [1857], in: idem, The Works, ed. E. T. Cook / A. Wedderburn, vol. 15, London 1904, 27

[6] McLuhan 1964: 247 f.

[7] See Heilmann 2010: 131

ARCHIVAL SAMPLING, ITS PROVOCATION BY SIGNAL RECORDING, AND FINAL SYNTHESIS IN DIGITAL SIGNAL PROCESSING. "Photofilm" in a media-epistemological perspective

Technical Sampling as Archival Action

Academic and artistic analysis has been concerned with "the archive" for years, in its sense as agency of cultural memory. This perspective has been turned upside down by focussing on the precise technologies of storage itself (be it analog, or "digitally" coded).

A media archaeological approach will less concentrate on a genre in cinema culture such as "photofilm" and its roots in the contemporary image archive, but take the subject *Sampling the Archive* more literally. Time-discrete digital *sampling* is the core operation of transducing, transforming and quantizing analog signals from the physical world into binary information - a "transsubstantiation" indeed, almost in terms of Catholic religious liturgy. This functional technical operation is embedded within a media-epistemological frame (the Heideggerean *Ge-stell*) of "technified" temporal intervals, cuts, slices. The discrete nature of the archive, in chronotechnical analysis, is therefore not identified in its administrative sense as institutional agency of cultural memory (especially Photo- and Film Archives and related Media Libraries), but in its micro-archival operations. This comes close to Foucault's neologistic application of that term (French *l'archive*), which rather relates to the Kantean notion of "conditions of possibility" (*a priori*) for memory in media culture.[8] Central topics are therefore the governing principles behind the so-called "digital archive", the techno-numerical micro-drama of A/D-conversion as a concretisation of photofilm-like discretization of the present moment, and finally the algorithmic essence of digitisation as micro-archival operation resulting in data compression.

Different from the electronic video or television image which has been analog 625 line-by-line sampling of visual evidence split into half-frames within a time window of 25th of a second, cinematography has initially been most literally "photo-film" already: the chrono-photographical sampling of movement or objects with a 24 frames / sec. frequency. If the essence of cinematography on celluloid is understood in its time-discrete act of recording, it is not simply an old medium outdated by digital cinema, but re-appears as the core operation of digital sampling. "Sampling the archive" of the past may be understood as a way of creative artistic research and recollection, but ifsampling is used as a *terminus technicus* of digital recording, recent technologies are "archiving the present", first of all.

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[8] Michel Foucault, Archaeology of Knowledge, New York 1972

An intermediary level between the genre "photofilm" and operative sampling are experiments with the photographic form, such as Douglas Gordon's installation *24 hours Psycho* from 1993 which slows down Hitchcock's film classic *Psycho* from 24 frames/sec. to 2 frames/sec., resulting in a projection of 24 hours. A reverse version of photofilm is Hiroshi Sugimoto's classic long-time photographic exposure of classic film theatre screens when finally all the projected images merge into one bright light - "an extreme condensation of time."[9] This reminds of a sonic equivalent, the "photosound" like performance of John Cage's composition for organ Organ²/ASLSP (As Slow as Possible) at Burchardi church in Halberstadt, Germany, where every tone lasts for years until the next key is dramatically struck. In synaesthetic consequence, the DVD "documentary" of the Halberstadt organ installation has been composed partly as "photofilm", partly chronophotographically.[10] Furthermore, there is Martin Reinhard's *tx-Transform* which implements the Slitscan recording technique reversing the time- and the space-axis (like an "explosion" diagram of a technical artefact)[11], and other technological or algorithmic explorations in cinematic time axis manipulation. But most radically, chrono-photographic sampling of the present moment returns within current digital signal processing itself.

A Real Archive of Movements: The *Encyclopaedia Cinematographica*

"Photofilm" deconstructs cinema back into its single frames and treats its elements as independent components. In that sense, photofilm is counter-balanced by the oxymoron of "photography of mouvement" which is cinematography in its most literal sense. At the Göttingen Institute for Scientific Film, between 1952-1994, on initiative by Gotthardt Wolf and ethologist Konrad Lorenz, the *Encyclopaedia Cinematographica* project has collected up to 4000 2-minute film samples (so-called *Bewegungspräparate*) of periodically repetitive expressions, mostly animal motion like birds on-the-fly, and occasional ethnologic ritual dance - which is a media-archaeological recursion of Muybridge's *Animal Locomotion* and Marey's chronophotography.[12] The filmic encyclopedy has been organised in a systematic matrix, intended to map the world of movements. Instead of sampling the film archives, film here, by samples

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[9] Mary Ann Doane, Has Time Become Space?, in: Liv Hausken (ed.), Thinking Media Aesthetics. Media Studies, Film Studies and the Arts, Frankfurt/M. et al. (Peter Lang) 2013, 89-108 (90)

[10] Sabine Groschup / Georg Weckwerth (eds.), (JC{639})#1-89, including a DVD version of the experimental film (JC{639}) by Sabine Groschup (A 2006 / 2012), Künstleredition 2013

[11] *tx-transform* is the title of a short film produced by Martin Reinhart with Virgil Widrich (35 mm, Austria 1998)

[12] Rudolf Geigy, Gedanken zur Schaffung einer Film-Enzyklopädie, in: Research Film, vol. 2, no 3 (1956), 145-150

of the moving world, results in an archive of motion. The depiction of movement is the true, media-archaeological message of cinematography. The recording into elementary so-called "cinematograms" gains coherence not from external (alphanumeric) metadata but from the sequence of "stilled movements" itself. The Encyclopaedia Cinematographica, while (mostly) being composed of animal locomotion, comprises non-organic physical "dance" as well: material mouvement performed by inanimate matter like the steam machine. With the machine rhythm, the film-mouvement becomes subject and object of cinematography itself.

Typographic Temporality

Has "photofilm" in its aesthetics of apparently motionless image sequences realized what Henri Bergson has missed in early cinematography which is film itself as endurance, *durée*? Or is it a remediation of photography to film, a quality which Marshall McLuhan claimed for an appropriate "media ecology" where the new technologies do not discard with the old media but rather subtly displace them, while maintaining qualities and virtues of the preceding ones?[13]

The phonetic alphabet as cultural technique of speech-writing once "made possible the visual and uniform fragmentation of time. [...] In the space-time world of electric technology, the older mechanical time begins to feel unacceptable."[14] McLuhan affiliates cinematography to the Gutenberg era of mechanical print technology, in contrast to the "flying spot" of the cathode ray tube, with its beams of electrons with no real momentary fixation (except the Iconoscope capacitor mosaic for intermediary storage and amplification). In linear scan line video and television, there is no discrete "picture element" like in alphabetic writing or photo-based film, rather a volatile, transient electron bombardment. The subtitle of Otto von Bronk's German patent from 1902[15] expresses the descriptive dilemma for that new form of media-temporal existence; the floating image is arrested into punctual stills. The inverse correlation to the "photofilm" is the hypothesis of so-called "picture elements" in electronic images indeed - an oxymoron which erraneously oscillates between the analog scan line video image and the digital pixel.

Geometrization of Time

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[13] See Baruch Gottlieb, Towards a Reasonable Ecology among the Media themselves, Den Haag (West) 2017
[14] Marshall McLuhan, Understanding Media, New York (McGraw Hill) 1964, 147
[15] DRP 155528 "Verfahren und Vorrichtung zum Fernsichtbarmachen von Bildern bzw. Gegenständen unter vorübergehender Auflösung der Bilder in parallele Punkreihen", granted June 12, 1902

Film-artistic communicating and processing of archives is a personal, subversive reinterpretation of official documents, and is "concerned with the emergence of memories that result from the programmatic processing of photographic archival material, as well as the archaeological excavation of previously stored 'impressions'"[16]. But let us not be seduced by the archaeological metaphor. Any film-artistic working with(in) an archive is only phenomenologically "based on the experience of memory" (ibid.); in fact it is subject to the radically non-mnemonic logics of administration (the symbolic order) and the techn-logics of storage.

The field of media theory is split between two very different approaches to this photographic and cinematographic memory. While media archaeologists describe the nondiscursive practices of the techno-logical archive, media phenomenologists analyze how phenomena in various media affect the human cognitive apparatus, its mind and senses.[17] The media-archaeological understanding of the archive is biased by the technomathematical analysis (the techno-*studium*), not mistaking storage for memory or even remembrance. The phenomenological reading of the archive corresponds with the Barthesean *punctum* when miracolously something like an electric spark crosses and short-circuits the temporal gap between the record from the past and its present reading.

Only in the human imagination, an encounter with the past as personal "unearthing" of various material at an official place of memory authority is a "search for the lost time"[18]. The term *temps perdu* itself, even if is has the literary connotation of *A la recherche du temps perdu* nowadays, in fact has been borrowed by Marcel Proust from Hermann von Helmholtz' techno-physiological measuring of human nerve signal runtime and latency[19], which is time-critical, pre-cinematic nervous (re-)action in the subconscious. According to Bergson, the human act of memorization is kind of an inner cinematography; the philosopher criticized the chrono-photographic sampling of continuous movement as a "mathematic" delusion. This technical metaphor matches G. W. F. Hegel's concept of cold mechanic memory as opposed to remembrance as subjective interiorization, literally expressed in the German term "Er-Innerung". While photography geometricizes the temporal moment into

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[16] As expressed in draft for the conference *Photofilm: Sampling the Archives* Samstag, November 18, 2017, at Open Society Archive, Budapest, 14th VERZIO Human Rights Documentary Festival

[17] 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)

[18] *Photofilm* conference draft

[19] See Henning Schmidgen, Die Helmholtz-Kurven. Auf der Spur der verlorenen Zeit, Berlin (Merve) 2009

two-dimensional space, chrono-photographical recording, just like digital signal processing, mathematizes movement itself indeed.

Sampling the Archive

The photographic image saves the volatile present moment from passing away, for future memory. The momentary recording exempts the present moment from disappearance, resulting in negentropic storage; on the other hand, such a recording is itself subject to entropic time at work: material decay and technical obsolescence. Once digitized, the speed of access and migration of photographic data increases, realligning the past to the present. Is photography and the cinematographic film from the past, once translated into pixels, still an archival medium at all? Conventional film reel or videotape extraction in archives of moving images did not grip on the single frames (like in post-production editing tools like the Steenbeck or the AVID), but on the whole reel tape, the storage medium only - entering the archive, but not accessing its smallest elements which are called *stocheia* in ancient Greek, the name for both physical atoms and alphabetic letters or mathematical numbers.

The primordial archival act, in fact, *is* sampling already, discretely filtering the (administrative) present, as symbolic ordering: discrete alphabetic notation, different from mechanical and electronic signal recording by the kymograph, magnetic recording and wireless transmission of audio or video). But with(in) computing, the symbolic order or the archive returns, with a decisive, literally time-critical difference: discreteness is introduced by clocking. In such a perspective, the archive is not about the past at all. "Storage is just a slowed-down transmission of an event - like the "freeze frame" in cinematography.[20] Archival stillness and processual media time are interlaced.[21]

Frequency Rate 24: Chronophotographic Sampling

As long as there has been celluloid-based cinematography, every film has been "photofilm" in the most literate sense. When it is not subjected to narrative emplotment, chronophotography results in the "statistic image" (Abraham Moles), which is rather diagrammatical than iconic. Marey decomposed movement into a multiplicity of equal and discrete units[22], while for Bergson, chronophotography are images not of

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[20] See Stefanie Diekmann / Winfried Gerling, Freeze Frames. Zum Verhältnis von Fotografie und Film, Bielefeld (transcript) 2010

[21] See David Green / Joanna Lowry (eds.), Stillness and Time. Photography and the Moving Image, Manchester (Cornerhouse) 2006

[22] Martha Braun, Picturing Time. The Work of Etinne-Jules Marey (1830-1904), University of Chicago Press, Chicago / London 1992, 277

movement through time, but of position and succession[23]. In its epoque, the chronophotograpical frame series has been perceived as a "true" representation of moving life; the cognitive apparatus quickly adapted to the cinematographic frequencies of the technical time axis.

The edited diary of Johann Wolfgang von Goethe is still patterned by the symbolic day-by-day rhythm[24], while in cinematography, the 24 hour frequency implodes into seconds. A 90 minute film contains around 130000 single frames. With its frequency rate of 24 frames / sec., each single frame is optically visible to human perception for a temporal micro-interval (Delta-*t*) of roughly 0,4 seconds. The kinematographic frequency performs a micro-differential form of "photofilm" already. This sublimely differs from the alternating current network of 50 hz which used to drive analog electronic television and video image timing (the interlacing frame rate in Europe); from such time-critical asymmetries in machine time result subliminal, rather unconscious irritations of human time consciousness. Machine time itself is irritated by asynchony in its hardwired and softcoded temporality; the difference to the US-American video frame rate of 60 cycles / sec. requires temporal translation by the Timebase Corrector.

In Salcher's and Mach's ballistic photography, the aim to catch a projectile on the fly required ultra-short momentum photography - actually positivizing Zenon's arrow paradox, achieved by short-circuited electric sparks both for illumination and triggering the photographic camera.[25] Nowadays, Femto-photography is "computational photography", coupled with realtime analysis of the present moment. With a frequency of 1 billion / sec., the elementary event of what is called "light" (the photonic emission itself) has been registered and can now be identified in "slow motion", folding the term "chrono-photography" upon itself.

Different Tempor(e)alities in Digital Culture - a Micro-Archival Regime

As technical media event (the intermittant celluloid transport) there has been the "moving still" always already, of which the experimental sub-genre of the "photo film" is a secondary re-entry on the media-dramaturgical level. The 16mm and 35mm film frame in traditional cinema relates to the pixelised new media imagery indeed. Digital culture, when analyzed from the perspective of storage theory, is a set of

[23] Braun 1992: 280

[24] Robert Steiger, Goethes Leben von Tag zu Tag, vol. 1: 1749-1775, Zurich / Munich (Artemis) 1982

[25] See Peter Berz, Mach I, in: Christoph Hoffmann / ders. (Hg.), Über Schall. Experiment und Medium in Ernst Machs und Peter Salchers Geschoßfotografie, Göttingen 2001, 372-451

"moving still". This corresponds with contemporary digitally computed images, since the digital computer in its von Neumann-architecture can not but perform one step at a time. In contrast to the discrete frame mechanism of the cinematographical apparatus, analogue signal recording media like electronic video registers even stillness by "moving" scan lines which is the physical nature of the time-signal. Remember the anlog video "still": When striking the video recorder "pause" key, the resulting "still image" still flickered, since the cathode ray tube had to re-write it again and again. Mechanical cinematography belonged to the "digital" regime already while analog signal recording (like the phonograph) came inbetween - which leads to a configuration of media which is different from any linear history of technologies. Digital sampling reconnects to chronophotographic film, by-passing the line-based electronic CRT image.

The immediate technical recording of the present has been a phenomenon of media culture since the shrinking exposure times of classical photography and cinematography, before electro-magnetic waves were applied to transmit signals with the speed of light. But different from "live" transmission in analog electronic radio and television, digital communication happens in "realtime" which suggests instantaneity but - when viewed under a time lense - is a process of constant micro-archiving of data for further processing. Whereas analog electronic broadcast media like radio and television have been "live" indeed in terms of electro-magnetic signal transmission, digital data processing is "archival" per definition: it takes intermediary computation. "Should the record-based approach to the archive be replaced by the functional approach in terms of algorithmic processing?"[26] Digital media culture is an archival structure - though a micro-archival one, the "algorithmic archive". With digital culture, for the first time, we are really living in an archive culture - not in its institutional cultural memory sense but in terms of micro-archiving procedures which dominate digital data processing.

The *Moving Still*

Like the photographic film already, but more radically, digital images are never transmitted "live". With CCD chip based digital photography, in the microprocessor memory the image desintegrates into single lines which are attributed with individual numerical addresses; thereby the rendering of a still image - this time different from flickering video electronic image

[26] Arnoud Glaudemans / Jacco Verburgt, The Archival Transition from Analogue to Digital: Revisiting Derrida and Flusser, in: Frans Smit / Arnoud Glaudemans / Rienk Jonker (eds.), Archives in Liquid Times, 's-Gravenhage (Stichting Archiefpublicaties) 2017, 121-137 (135)

- as well as nonlinear forward and backward search can be achieved if not live, but in computational realtime.[27]

There has been slow-motion and fast-motion' almost co-originary with the mechanization of cinematography itself. The digital difference, though, is in its mathematization, becoming an intelligent micro-archive. Random access to stored data is a key quality of digital media indeed; any storage can be adressed almost equally fast.[28] While celluloid film samples time but still preserves its linear ordering on the micro-level, digital media abondon with the human-centered phenomenology of temporal sequence, to put time fully under algorithmic control, transforming time into space, mapping the one-dimensional time signal into a multi-dimensional matrix.

Even if the digital computer was not born from time-discrete cinematography, a Turing Machine, when supplied with a perforated tape for forwarding the program data punched into that tape, looks like a film projector mechanism - with the difference that the tape can not only be read in ony direction, but can be rewritten by moving in both directions.[29] The Turing machine diagram reminds of the typewriter as well, with its rhythm controlled by a clock mechanism. All such highly differentiating machines arise from one overarching epitemic dispositive which is time-discrete data processing.

While for Roland Barthes photography has been a message without code, the digital image consists of coded units entirely. With image-creating apparatuses like tablets and smartphones, the metaphor of photo or film is already an aesthetic anachronism, a retro-nostalgia where the content of the new medium is the older one for "remediation".[30] The deeper media-epistemological truth is the always already discrete essence of both chronophotogratography and digital media. In an unexpected techno-logical (rather than evolutionary or "historic") recursion, the digital image returns to the time-discrete mechanics of cinematography. Cinema had prepared for digital media since it has already been based on sampling the present moment, or rather: movement, which in

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[27] See Johannes Webers, Handbuch der Film- und Videotechnik. Die Aufnahme, Speicherung, Bearbeitung und Wiedergabe audio-visueller Programme, Munich (Franzis) 1991, chap. 1.3 "Abtaster mit Halbleiter-Zeilensensoren", 561

[28] See Lev Manovich, The language of the New Media, Cambridge, Mass. (MIT Press) 2001

[29] Alan Turing, On Computable Numbers, with an Application to the Entscheidungsproblem, in: Proceedings of the London Mathematical Society (2), vol. 42 (1937), 230-265; see as well Lev Manovich, Cinema and Digital Media in: Hans Peter Schwarz / Jeffrey Shaw (eds.), Perspectives of Media Art, Ostfildern (Cantz) 1996, 42-48

[30] See Jay David Bolter / Richard Grusin, Remediation. Understanding New Media, Cambridge, Mass. / London (MIT Press) 1999

Aristotle's definition generates the notion of "time" by discrete counting in numbers "between the before and the after".

Decisively different from the electronic video and television image in analog signal tranduction, the so-called "pixel" again provides for an elementary unit in digital *imaging* indeed. Even if it still contains a minimum amount of electric energy (voltage), different from the high-voltage produced cathode ray, its significance is not in its energy any more (apart from its secondary effect of light emission by LED) but a micro-embodiment of information as defined by cybernetic communication theory (Wiener / Shannon). When single photographic frames are digitally sampled, "photofilm" escalates from the humanly perceived screen event into technology itself.

Media artist Angela Bulloch took a film sequence of Michelangelo Antonioni´s film *Blow up* (1966) - where the closer the camera looks, the less is the apparent murder an evidence. Bulloch enlarged its digital scan in great blocks of its single pixels[31] - a desillusion of the image betrayal of the human eye, reavealing the scanner-gaze of the computer which is media-archaeological, looking at a different kind of film archive. Pixelization is the radical up-dating of "photofilm". Bulloch's digital sampling of Antonioni's film *Zabriskie Point* (one frame / sec., instead of 24 in mechanical projection) not only slows down the projection of its single image pixels, but enlarges them to 50 x 50 cm shining cubes, like an archival monument of the units of sampling and a media-archaeological reminder of what actually happens within a CCD chip in digital photography and video.[32]

It requires media archaeological aesthetics for an *analytic* "close reading" of high-speed media processes, by freezing the motion, slowing it down, and enlarging the single frames. This is *archaizing* in the spatial & temporal sense, reducing movement to its smallest units. Konrad Zuse's first programmable binary computer Z1 has been driven by a hand crank, thereby calculating with data cycles of 4 Hz. This frequency comes closer to the transport mechanism of a film camera than to fully electronic speed; in fact, Zuse later, for his improved Z3 computer, applied punched celluloid film from discarded cinema rolls for program instruction input. This is a re-entry of the conceptual discreteness from within the materiality of film storage medium itself; with the rhythm of the time-discrete, escapement-driven clock-work.

- Kanonisierung der Erinnerung durch Häufigkeit der Klicks im Internet; Logik der Suchmaschinen; Fokussierung auf "shoking moments"

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[31] Installation *Blow_Up T.V.* by Angela Bulloch, gallery Schipper & Krome, Berlin, Oktober / November 2000

[32] Angela Bulloch's exhibition *Z Point* at Kunsthalle Glarus (Switzerland), September / November 2001, curated by Beatrix Ruf

- Rolle von Film und Fernsehen: Holocaust TV-Serie (1978); Dokumentarfilm Shoah (1985), Spielfilm Schindlers Liste (1994)

Digital No-Time

In the world of the digital, physical entropy (which gives time its direction) is replaced by informational entropy. At least in principle (as mathematical "theory" of communication), the digital image does not degrade by copying, while silver-based photography is subject to such degradation.[33] Rodowick criticizes the digital image for its inability to convey a sense of passing time or pastness. The digital "image" is just a function of numerical symbols, not iconic in the sense of photo-chemical impressions at all[34], resulting in counting with numerical differences (*zählen*) rather than symbolical narratives (*erzählen*). In return, this allows for sampling the digital archive by similarity-based image matching. In algorithmic space, not only every film sequence, but every still in a film, even more: every pixel in a film frame can be discretely addressed, no longer subject titles reduce images to words, but alphanumerical source code refers to alphanumerical numbers. The archive transforms into a mathematically defined space; genuinely image-based image retrieval generates an archive beyond iconologicial semantics.[35]

Turning Movement into a Techno-Mathematical Archive: MPEG

"Photofilm" is a sequence of repetitive stills, arranged in a poetic order, metadated by narrative text or voice-over into drama, its single *Einstellung* consists of identical photographic frames which are redundant in terms of communication theory - which is the reverse ratio of digital video compression by interframe coding. "In the compression algorithm of a digital image, only what changes in the shot is renewed."[36] Digital video compression as basis for *streaming images* is sublimely based on algorithmic operations, resulting in a qualitative reduction of movement into mathematical vectors. Only parts and sections of the image are updated at a temporal moment. MPEG technologies for video

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

[34] D. N. Rodowick, The Virtual Life of Film, Cambridge, MA (Harvard UP) 2007

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

[36] Babette Mangolte, Afterwards: A Matter of Time, in: Richard Allen / Malcolm Turvey (eds.), Camera Obscura, Camera Lucida, Amsterdam (AUP) 2003, 261-275 (264)

compression transform the plenitude of movement into partial sampling of stills and below, dividing each frame into small blocks of pixels in order to analyze changes from one frame to the next. Thereby, the elementary unit of photofilm is deconstructed into the sub-frame segment. A group of frames is established around one key frame at intervals. On the basis of key frames, predictive pictures are established in between to predict the location of each block of pixels. Movement only takes place through updates of certain sections of the image, while the rest of the frame is replayed as before.[37] In such a delicate operation based on micro-temporal events; only parts and sections of the image are updated at a temporal moment. The conventional film frame is not simply transsubstantiated by digitization; it is numericized and thus becomes accessible for computation, making explicit operative reality of Bergson's critique of the implicit mathematicity of discrete chrono-photographic image sequences. At that moment, photofilm has imploded into micro-archival action.

THE IMAGE FUNCTION, or: ON THE OXYMORON OF "DIGITAL VISIBILITY"

Disappearance of the "Image of Man" (Foucault)?

Human vision has become posthuman already. Man nowadays finds him- and herself in a situation where the pandemic Corona virus crisis has pushed the "digitalization" of communication in favour of "home office" video conferencing, and academic online teaching. The corporal image of man reappears on computer screens, but temporarily disappears in the actual medium channel. Michel Foucault's apocalyptic metaphor that the image of the human will disappear like the shape of a human face drawn into the sand at the sea shore[38] becomes micro-temporalized by actual computing, which is recording, transduction, processing, transmission and storage of man as "data face". Such an *imaging* is only "apparently" (literally) about visibility any more.

Images as a function of the punched card

The "digital image" is an oxymoron: it is either not "digital", or no "image". An automatically woven tissue "à la mémoire" of Joseph-Marie Jacquard is a proto-digital image indeed. The portrait of the inventor of the image-weaving machine, which shows him in the act of punching

[37] See Trond Lundemo, In the Kingdom of Shadows. Cinematic Movement and Its Digital Ghost, in: Pelle Snickars and Patrick Vonderau (eds.), The YouTube Reader, Stockholm (National Library of Sweden) 2008, 314-329 (316 f.)

[38] "[…] like a face drawn in sand at the edge of the sea": Michel Foucault, The Order of Things. An Archaeology of the Human Sciences, London et al. (Routledge) 2009, 422

cards for textile patterns, hereby becomes an image function of his own invention, and his "memory" a function of this stored-program device.[39] In its digital reproduction, the image from the collection of the Science Museum in London, when enlarged, dissolves into pixels itself - actually reminding of the "binary" nature of textile weaving on the loom, and its ancient relation to the episteme of mathematics.[40]

But who is the actual artist here? Michel Marie Carquillat the weaver (*tisseur*) "d'après Claude Bonnefond"? The real agency, though, is the machine, since "[t]his portrait of Jacquard was woven in silk on a Jacquard loom and required 24,000 punched cards to create (1839). It was only produced to order. Charles Babbage owned one of these portraits; it inspired him in using perforated cards in his Analytical Engine."[41]

Textile imagery that was created by the Jacquard loom was derived from punched cards, which literally in-formed the weaving of images[42] just like the musical roll in the player piano. Charles Babbage contained the punched-card based woven portrait of Jacquard in his office, while applying the punched card for numerical computing himself. This operational generalization of the mechanic agency of image production, in reverse, transformed the ontological state of the "image" itself. The automatization and mathematization of its production - independent of the artistic hand - completely interrupts the relation between human image recognition on the one side, and its internal machine "vision" on the other side. There is no such thing like a computational image phenomenology. There can be no "anthropology of the digital image" since the "digital" in the becoming of such images is excluded from human visual perception. Ada Lovelace, in her notes on the Analytical Engine, pointed to its quality of computationally weaving "algebraic patterns". At that moment, the mechanism became transvisual, and "images" only remain a mere sub-group of numerical data processing. In Heidegger's sense, the visual image disappears into the Cartesean

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[39] For a digital scan of "A la mémoire de J.M. Jacquard", see https://commons.wikimedia.org/wiki/File:A_la_m%C3%A9moire_de_J.M._Jacquard.jpg, accessed November 24, 2020

[40] Ellen Harlizius-Klück, Weberei als *episteme* und die Genese der deduktiven Mathematik, Berlin (Edition Ebersbach) 2004

[41] Image caption in the Wikipedia entry "Jacquard Machine", https://en.wikipedia.org/wiki/Jacquard_machine, accessed August 12, 2020

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

"world picture"[43]: literally, the Cartesian grid, which is machine vision as a function of the numerical (measuring, scientific) approach to nature.

In textile image processing, the fabrication of the tissue - just like with electronic pixel images - follows a pre-structuring by lines, columns and punctual elements; such image weaving operations result from the economy within the machine which is thereby techno-logical. Whereas Charles Babbage, for his Analytical Engine, was inspired by the image-producing Jacquard loom as a programmable mechanism to calculate textile patterns, later the number crunching machine called "computer", in reverse, produces images from numbers. This kind of recursive Moebius loop is the time figure of media archaeology, alternative to cultural historiography in terms of evolution, development, progress. Therefore the media-historical view as suggested in the subtitle of the conference *Technologies de la visibilité. De l'image ancienne à l'image hypermoderne*[44], is opposed to, e. g., Vilém Flusser's understanding of the digital image as a recursion of the iconoclastic textualization of the pre-historic image.[45] There is rather a techno*lógos* at work here, which can be media-epistemologically specified down to its techno-logical components, which is material hardware, and mathematical software.

Images from Data

The "digital image" is an oxymoron; it is rather a *log-icon*[46]. "When we process pictures by digital computer, we usually want to regard them as discrete arrays of numbers, i. e., as matrices, rather than as functions. [...] Such a picture function will be called a *digital picture function*."[47] The Turing machine is not part of "sensorial media"[48] any more. This makes a

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[43] Martin Heidegger, The Age of the World Picture [GO "Die Zeit des Weltbildes", lecture 1938], in: idem, The Question Concerning Technology and Other Essays, New York, NY (Garland) 1977, 115-154

[44] Paris, 26 November 2020, co-organised by Dipartimento di Filosofia e Scienze dell'Educazione, Università di Torino, and the Collège des Bernardins, Paris

[45] Vilém Flusser, Into the Universe of Technical Images, Minneapolis (University of Minnesota Press) 2011

[46] A neologism coined in a PhD thesis within the Graduate School "North West Italy Philosophy Consortium": Francesco Striano, Through the Screen. Towards a Philosophical Mediology, University of Turino (summer 2020). See as well idem, Log.*icona*. La co-originarietà di lógos e eikón riemerge nel digitale, in: Nicola Russo / Joaquin Mutchinick (eds.), Immagine e Memoria nell'Era Digitale [Quaderni di Mechane, no. 1], Milano / Udine (Mimesis) 2020, 77-95

[47] Azriel Rosenfeld, Picture Processing by Computer, New York / London (Academic Press) 1969, 2

[48] Doron Galili, Postmediales Wissen um 1900. Zur Medienarchäologie des

techno-epistemic, rather than media-phenomenological, analysis mandatory. The intervention of computation into technical "image" storage and transmission is not related to any kind of bodily sensation any more that gets lost in the moment of analog-to-digital conversion, but rather linked to the techno-reasoning "mind machine".

A media-epistemic rupture occurs when analog optical signals become binary "data". This refers to its techno*lógos* rather than to its material medium quality. The ubiquitous digitization of signal transmission in communication does not change the electro-physical quality of the media channel itself, but the essence of its modulation. While the "analog" electronic transduction of optical into electric signals preserves its indexical trace, and its quasi-photographic *punctum* (in Barthes's sense) still remains intact, digitization is a translation, allowing for a conceptual abstraction into mathematical intelligence. In a double existence, there is still the signal in the physical sense; the expression of "l'image numérique" actually dissimulates the material embodiment of the computation "number", of "bit", in actual computing. Still, in terms of information theory, the physical signal is endowed with a second, conceptual, "virtual" body, which allows for its metamorphosis in an image not for direct human view, but as second-order "imagination" (Flusser) of data processing, which replaces traditional visual aesthetics. Histograms, e. g., calculate the entropy value - the "information" - of a digitized image.

With its double techno- and logical digitization, the "image" not only loses its optical aspect like in analog transmission already, but its indexical quality at all - or rather retains it in a different formation, as it has been coined as "diagrammatic iconicity" by Charles S. Peirce.

The following analysis is restricted to technically processed "images", which justifies their definition as "medium" - different from other forms of image formations as cultural techniques. For the technical image, first of all, it requires actual, and active, media matter, which is non-visual electronic, and digital signal processing, as precondition to finally unfold at all as "images" for final human, or recently non-human, perception. To put it dialectically, the "image" has to become a non-image first, before it can reappear on the interfaces of media culture. During its media being, there is nothing like an "image" at all in its infra-technical existence. Before, and while, the technical image finally becomes an "image" on some user interface, its coming-into-being and existence is radically non-iconic. This intermediary state is no simple pre-existence of the final "image", but is its truly techno-logical alternative which deserves epistemic attention. To grasp this non-visible "other" of the image, it requires a different set of technical terms than the transcendent signifier "image", such as bijective mapping or the one-line scanning in

electronics, which transforms the optical image into a media operation. In the previous media configurations, the world appears as always already directed at human senses.[49] The specificity of most of the technical configurations of optical *communication* media (its material *causa materialis*, its software *causa formalis*, its transmissional *causa finalis* and communicative *causa efficiens*[50]) can only be explained by their anthropocentric, "intentional" (Husserl) orientation at human visual perception indeed. But evidence of an *implicit* "image" knowledge (McLuhan's *medium* message) is revealed by its inner-technical existence-as-operation only, a technical icono*lógos* which has escaped visual culture - with its focus on iconology - so far. Against the dominant "screen essentialism" of cultural and visual studies (Nick Montfort 2004), media archaeology radically focuses on the material, and techno-logical processes that produce "images" before they become visual on optical interfaces like the computer screen.[51] As can be demonstrated by the case of the so-called Hidden Surface Algorithm in computer graphics, the digital "image" is not primarily structured by vision any more "but by a theory of the nature of objects, a computational ontology for which the rendered image is only one of many possible expressions"[52].

Radar vision

So-called "optical" media archaeologically observe visual reality not iconologically, but with the "cold gaze": "Evidently a different nature opens itself to the camera than opens to the naked eye."[53] But with the CCD chip, a dramatic turn of Benjamin's insight occurs: This is not simply a technical transduction, a scanning of the optical lense "image" into its

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[49] In the medium, the wordls is always already "eine auf die Sinne zugerichtete." Rolf Grossmann, Soundcultures, Audio Cultures, Auditory Cultures. Der Diskurs um die auditive Kultur und die Musikwissenschaft, in: Navigationen. Zeitschrift für Medien- und Kulturwissenschaften, thematic issue "Von akustischen Medien zur auditiven Kultur", ed. Bettina Schlüter / Axel Volmar, vol. 15, no. 2 (2015), 24 seq.

[50] See Martin Heidegger, Die Frage nach der Technik, in: idem, Reden und Aufsätze, Pfullingen (Neske) 1954, 13-44 (10); engl. The Question Concerning Technology and Other Essays, New York, NY (Harper and Row) 1977)

[51] See Jacob Gaboury, Hidden Surface Problems: On the Digital Image as Material Object, in: Journal of Visual Culture, vol. 14, no. 1 (2xxx), 40-60 (40)

[52] Gaboury 2xxx: 47

[53] Walter Benjamin, The Work of Art in the Age of Mechanical Reproduction [1936], in: Hanna Arendt (ed. and introduction), Illuminations, London (Fontana Press) 1973, 238. See as well Ferdinand Buchholtz (ed.), Der gefährliche Augenblick. Eine Sammlung von Bildern und Berichten. Mit einer Einleitung von Ernst Jünger (1931)

electric voltage "analog", any more, but its radical mathematization: lots of data, once sampled into the digital matrix, become calculable.

Media archaeology is not only a form of research, but as well an aesthetic of observation - a passion for distancing, corresponding with the gaze of the camera (Dziga Vertov's "Kinoglaz"). But the digital monitoring system has long replaced the tele*visual* panoptical regime of video cameras by dataveillance in patterns and clustering.

An image, for media archaeologists, is different from what an image is to art historians, or to Visual Studies. Media archaeology is akin to the gaze of the optical scanner which frees, or liberates, images from culture.[54] Digital *imaging* is both an object, and an agency of media-active archaeology. The electronic tunnel microscope does not actually transfer "images" of the atomic surface of matter, but measures its objects as signal functions. By means of signal processing, it analyses its object by matching data statistically and representing these calculations as images. It is only by rendering and formatting such signals as digital data that these calculations return as "images" to human perception.

Radar "vision" has already been a "system of measurement rather than communication"[55]. Just like bats do not perceive space visually, but by ultrasound echo orientation, and the submarine sonar, the radar "image" is nothing but a function of electromagnetic signal run-time. Radar unfolds between the analog and the digital image. It is an analog imaging technique that renders on-screen the surrounding area of an antenna, while on the level of signal transfer it operates with discrete impulse- and duplex technology. The radar image is rather an analytical measuring device than a medium of visual representation like television. The radar "image" (if at all) 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"[56]. Both TV and radar, though, are based on the same cathode ray imaging tube. Actually the tube production for the German TV receiver set E1, which was ready to go into mass production in 1939, was immediately redirected for military uses after the outbreak of WWII. That is how media-archaeological analysis differs from mass media studies: It does not focus on image transmission as practised in broadcasting, but rather like radar, it gathers intelligence from technological interaction itself, from within its "black box".

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[54] See Claus Pias (ed.), Kulturfrei Bilder, Berlin (Kulturverlag Kadmos) forthcoming

[55] Woodward 1950: 108, as quoted in: Friedrich Wilhelm Hagemeyer, Die Entstehung von Informationskonzepten in der Nachrichtentechnik, PhD thesis Berlin (Freie Universität, FB Philosophie u. Sozialwissenschaften) 19xx, 341

[56] "[…] das inverse Prinzip zum Rundfunk": Hagemeyer 1979: 341

Satellite "Imaging"

The Greek notion of "(h)istor" (for witness) derives from the linguistic root *w(e)id* (to see, to know) just like in "video".[57] The visual metaphor of ancient Greek *theorein* is linked to theatre and to "evidence" in law. Media "theory" itself recognises that the occidental links between the optical regime and epistemological insight is being challenged by the numerical sublime, that is: mathematical calculation. This extends to orbital digital *imaging*: In his project Experiments in Satellite Media Arts (ESMA), from June 18 to July 1 at migrating art & science lab MAKROLAB, and stationed in rural Scotland from May through July 2002, Marko Peljhan downloaded and manipulated "satellite images, raw satellite television feeds, and electronic/digital sounds in an effort to generate a series of 'orbital animations'"[58]. Such artistic media archaeology reminds of the fact that the satellite "image" is not existing in the iconic sense any more; it rather dissolves into various practices of sensing, sampling, computing, cache storing, and transmitting signals, which have been converted to data, in order to become "stored / archived or put into circulation"[59]. It is only in the ground stations that this data stream is processed into an "image" format, directed to human perception. This is already an *othering*: the data formation is altered, combined, colorized, in order to become an "image" at all. Horst Völz' developed the digital data tape recorder M3 for the intermediary image storage (delayed / suspended transmission) in outer space (the Phobos mission). Before such images are archived in to institutional sense, the actual technical *l'archive* (in Foucault's sense) defines what can be made visible to humans *by machines* at all, unfolding in an area of techno-machinic spectrality with algorithmic force.[60]

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, and electronic cameras "see for us." Buth with the CCD chip in digital cameras, the decisive event is not the visible any more. Media scholar Lisa Parks adds the extra-terrestrial point

[57] This derivation has been contested by Edwin D. Floyd, The Sources of Greek "(H)Istor" "Judge, Witness", in: Glotta LXVIII (1990), 157-166
[58] http://www.artscatalyst.org/htm/makrolab.htm, accessed xxx
[59] Electronic communication Lisa Parks, December 2000
[60] See Lisa Parks, Cultures in Orbit: Satellites and the Televisual (Duke University Press) 2003

of view: Satellites occupy a position that no human eye can ever replace.[61] Media-active vision is a non-human, unearthly position indeed.

In their installation *Polar* for the Canon ARTLAB, Tokyo, in 1991, Carsten Nicolai and Marko Peljhan referred to the changing process of invisible information. In the novel *Solaris* by Stanislav Lem from 1972, which Andrej Tarkowskij later turned into a film, the "Ocean" is a sea-like substance of an unknown planet reflecting human thoughts. Data visualization makes visible the otherwise unvisible (for humans), and corresponds with the "mathematical sublime" (big data which cannot be organized by human perception into a coherent image) which Immanuel Kant differentiates from the "dynamical sublime" that reminds human vision of its limits ("unsere unsere physische Ohnmacht"[62]).

Visual Knowledge? Machine Vision, and Artificial Intelligence

Visual interfaces enact *monitoring* in all senses, while its technical machinery retreats into total opaqueness, into invisibility. But visual human-machine interfaces become redundant in direct machine-to-machine-communication, resulting in an ultimate transparency. Digital calculation does not refer to the imaginary nor to a world outside; the physical reality behind the screen is circuitry and electric current only.

Human "image" recognition is always prefigured by cultural iconology already, parallel to the always already "musical" perception of sonic signals. For immediate signal processing in operative, rather than culturally performative contexts, such as military or industrial image recognition, only machine vision can get rid of the hermeneutic trap to which a human, placed at the monitor as visual interface, is subject. As expressed in several video installations and post-cinematic essay films like *Eye / Machine I-III* by director Harun Farocki (2001), once surveillance cameras (CCTV) are coupled to nonhuman pattern recognition systems (like Rosenblatt's Perceptron from 1958), a different kind of *understanding images by media* takes place. The "goal behind the production of 'technical images'" may have been phenomenologically "prefigured by photography", but is now "extending beyond it, [...] not only to record and preserve, but also to recognize [...], deceive and conceal"[63].

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

[62] Immanuel Kant,Kritik der Urteilskraft, Berlin 1790, B 105, as quoted in: Johannes Grave, entry "Erhabene, das", in: U. Pfisterer U. (ed.), Metzler Lexikon Kunstwissenschaft, Stuttgart (J. B. Metzler) 2011, 113-117 (115)

[63] Susana Nascimento Duarte, Archaeological practices of cinema: the critique of representation in Straub / Huillet and Farocki, in: Filipe Martins (ed.), *Memory and Aesthetic Experience. Essays on Cinema, Media and*

Until the arrival of Artificial Intelligence by artificial neural nets and "deep" machine learning, it has only been the human who finally transforms the perception of optical signals into the meaningful (re-)cognition of an "image" in the cultural sense. But with the convolutional if / then structure computer algorithms "that improve automatically through experience"[64], recursive machine learning implements the neuro-cybernetic feedback mechanisms, which had been a privilege of human visual perception so far, into machine vision.

With the arrival of machine cognition and "deep" machine learning, the "image" as a concept no longer makes sense from the human point of perception only. The "technical image" (Vilém Flusser), as medium, is redefined by machine vision itself. In a media archaeological epistemology, the dramatic difference between human vision and machine *imaging* should not be smoothed or humanised by the media theatrical scenes of visual interfaces, such as the computer screen, but rather should be drastically irritated there.

Where the electronic video "image" has no human producer, and is even devoid of human intention, and where it is not viewed by human beings but analysed by automatic recognition software, a different *aisthesis* of the "image" arises - which is generative aesthetics in epistemological terms.

Human and / or Machine Vision

From the moment of *sampling* and quantisation (*numéritasiation*) of visual works of art, parallel to its human discourse, another "gaze" emerges, which is non-human in terms of iconology, but still cultural in terms of technology. Image cognition is not restricted to human neurons any more.

The concern with "technical images", in return, leads to an increased awareness of the "technical" essence of human visual perception itself, its so-called "neuromediality"[65]. Like the electronic image generation on

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Cognition, Porto (Faculty of Arts, University of Porto) 2020, 91-118 (109), paraphrasing N. Alter, The Political Im/perceptinble: Farocki's Images of the World and the Inscription of War, in: Thomas Elsaesser (ed.), Harun Farocki: Working on the Sight Lines, Amsterdam (Amsterdam University Press) 2004, 211-234 (218)

[64] Boachang Zang, Machine Learning and visual perception, Beijing (de Gruyter) 2020, 5

[65] See the academic call for a professorship of "Neuromedialität" at the University of Vienna, 17 November, 2020 = https://www.academics.de/jobs/tenure-track-professur-fuer-

the screen, neuronal processes react to visual signals in a direct manner, by serially examining them in brief temporal intervals. While utilizing almost no, or rather ephemeral "echo" intermediary memory, the neural impulses that have been derived from visual perception are organized quasi-automatically into such features as edge, color, depth, and motion. At what level does a set of data, a format, become an image at all? Does a visual configuration of optical signals for human perception turn into an "image" by verbal description (*ekphrasis*) only, or is the "image" independent from human awareness already? As it has been defined by Hermann von Helmholtz for musical sensation and optical character recognition, it is only by cognition that such data become an "image". Without human interpretation of certain visual patterns, the image would just be a cluster of data. Optical signals become information in the eye of the beholder only, while the computer can deal with the symbolical analysis of physical data only, not with the imaginary. But with "deep" machine learning, computing starts to emulate this human quality - as an ultimate victory of image anthropocentrism. To improve the *human* interpretability of Convolutional Neuronal Nets, "CNN visualization is well utilized as a qualitative analysis method, which translates the internal features into visually perceptible patterns."[66] Ironically, for humans to still "understand" how a CNN "sees" the world, it takes functional visualization itself - a re-entry of the "image" as diagram, into the non-visual world of computing.

The "Cold" Media-Archaeological Gaze in Artistic Research: Pixel Works

An artistic answer to media archaeology's *distancing algorithmic* approach to images is media archaeology as an art form itself. Media archaeological art derives sparks of insight and knowledge from close analysis of technology by aesthetic means (with installations as arguments), complementary to discursive academic media theory. These are two branches (the "Y" model) emanating from one epistemic concern.

Truly media-archaeological art demonstrations have been Douglas Gordon's museum film installation *24 hours "Psycho"* or Angela Bulloch's dissolving single film frames into monumental three-dimensional pixel blocks. What is both epistemologically and aesthetically attractive in dissolving a historical painting into its raw pixel fields is its formal, not hermeneutic analysis; the cybernetic fascination of discovering governing

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neuromedialitaet-universitaet-wien-wien-1032370, accessed 23 November, 2020

[66] Qin, Zhuwei, Funxun Yu, Chenchen Liu, and Xiang Chen, How convolutional neural network see the world. A survey of convolutional neural network visualization methods, in: Mathematical Foundations of Computing 1, no. 2 (2018), 149–80, Abstract

rules which escape the traditional author's intentionality is discourse analysis in the best Foucauldean "archaeological" sense.

Media artist Angela Bulloch's series of Pixel Works dissolve a cinematographic frame, after digital sampling, into technically engineered macro-pixels. With the neon-light emitted by an enlarged single material pixel block of 50 x 50 cm, the distance between the viewer and a group of pixels must be large in order to discern fractals of a cinematographic "image". In her installation *Blow up TV*, Bulloch uses a key sequence from Michelangelo Antonioni's film *Blow Up* (1966): the protagonist, a photographer, hides behind a tree taking photos of a loving couple. Later, in the development of the negatives, he realizes that he might have occasionally registered a murder scene, but in trying to identify the object on the spot, the more the photographic section is enlarged, the more it becomes granular (not: pixellized), and the less is the apparent murder an evidence. Media artist Bulloch extends this process of identification by yet another magnification, enlarging the digital scan of this film scene in great material blocks of its single pixels. Thus the image *implodes* by slowing down the cinematographic motion to one digit per second (thus undermining the copyright which is based on the recognizability of the motive for the spectator), and on the other hand the original image *explodes* within a sequential modular system of purpose-build so-called *pixel boxes*, where one pixel is represented in a 50 x 50 cm monitor which are attached to complex RGB lighting systems which can be generated and programmed with any digital information[67] - a desillusion of the image betrayal of the human eye, reavealing the scanner-gaze of the computer which is media-archaeological, looking at a different kind of archive, not looking for letters any more. The pixel modules 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.

In a rigorous materialist interpretation of Immanuel Kant's notion of *a priori* and Michel Foucault's *Archéologie du Savoir*, media archaeology "looks" at the image on the level of its techno-mathematical existence - be it the geometrical construction rule of Renaissance perspective, or the neighbourhood of pixels in a digitally sampled painting. A digitized file of Gustav Klimt's painting *Die Freundinnen*, a masterpieces of the Vienna secessionist from 1916/17, has been algorithmically analyzed into its picture elements and printed out by the Georgian artist Tea Nili.[68] The pixel nature of a digital image matrix (different from vector imaging, such as on the Vectrex computer monitor), which is accentuated here in a representational way, returns from within computing, once Nili's images

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[67] Installation *BLOW_UP T.V.* by Angela Bulloch in the gallery Schipper & Krome, Berlin, September to November 2000

[68] See *Freundinnen (Gustav Klimt Series)*, 2014, from: Catalogue Tea Nili. Selected Work 2012-2014, edited by Lily Fürstenow-Khositashvili, Berlin

are reproduced, and projected, from a digital projector. As such, the digital image itself can be "pixelized" by image scale maximation.

While humans, when looking at this image at a distance, are still trapped by the iconic *Gestalt*, the digital ground gets evident only in further resolution at close distance. For the "eyes" of the machine, there is no difference between a matrix of distributed color values and *Gestalt*, for human phenomenology only a figure emerges (unless the computer is neuro-informationally trained as "Perceptron" to recognize shapes such as in OCR, which has been practised in classic cybernetic "informational aesthetics" by Moles, Steinbuch, Bense, and as "Deep Learning" in the hyper-computational present.

When compared with its "original", this is media-archaeological image analytics indeed. "This unusual reduction technique reveals the pixel grids - the underlying structure of each digitally photographed image"[69] - a media-active reduction of visual iconology to its inherent logics, to its *arché*. A photographic print of a pixel, though, is no indexical digital picture element any more, since it has lost contact with the integrated circuitry of voltage derived from optical signals - cut off from digital control.

The "digital image" is always a *double*. Its "pixels" as elementary unit has two bodies in computing - a material and an informational one. Any graphic, though being coded symbolically, unit requires physical light to become vision in human terms.

The digital image screen is both optical and sublime, in the double sense of "technology". It is composed of discrete units, the "picture elements", which are both physical and logical units. As a electrotechnical phenomenon they are constituted by three colours with adjustable brightness, whose lighting is conceptually determined by discrete quantities of binary information (code), but materially stored in a memory matrix. Different from the time-continuous scan line in analog television or video, the digital image is time-discretely coded; the electrical signal becomes an abrupt impulse. The literal video "codecs" allow for mathematical (algorithmic) intelligence to seize the image which, in terms of communication engineering, becomes information. Its digital-to-analog re-conversion, for display in a visual form in order to become perceivable to humans at all, is nothing but a collateral phenomenon.

Nili's algorithmic, CCD chip-based pixelisation of "analog" paintings comes close to experiments in Digital Humanities laboratories which count with the nonhuman gaze of digital image processing not as

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[69] Curator Lily Fürstenow-Khositashvili, Erasure. Afterword to the catalogue: Tea Nili. Selected Work 2012-2014, Berlin

substitution but augmentation of traditional humanist (art historical) image analysis. "There's a significant difference between the way our brain perceives colour spectrums as compared to the way digital photography and computer software processes colour" (Fürstenow-Khositashvili).

There is an uncertainty equation at work, known to quantum physics as well as to cognitive psychology: We see either figure or ground. The closer we recognize the slight chromoatic modulations by close pixel analysis, "the contours dissolve in abstractions with vague outlines" (Fürstenow-Khositashvili). By reducing a painting such as Klimt's *Freundinnen* to its dominant colour pixels which are green-blue and reddish-orange, Nili reveals the painter's colour palette. According to Martin Heidegger, with spectography as scientific analysis of light into wave lenghts the colour itself disappears. The closer we look at the image in media-archaeological ways, the more its cultural semantic is lost, while - the other way round - iconological analysis of art historical works misses their "mediality".

The pixel manipulation is a personal interpretation, a subjective appropriation of the original work of art - in the best tradition of print, copper and lithographic engravings as individual "critique" of the original, "printmaking as metaphor for translation" in terms of Ségolène Le Men.[70]

At the same time, the radical pixelisation is a reminder of the "blind spot" in most art-historical presentation of images from beamers in lectures: this is not the real thing.

Between Analog Scanning and Digital "Reading" of the Image

Back to the painting itself: How is Gustav Klimt's *Die Freundinnen* (1916) usually represented for analysis? Johann Joachim Winckelmann once moved from Nöthnitz castle in Saxony, where he had been employed as a librarian, to the collections of art in Rome: Not being critically content with (excellent) copper engravings of ancient sculpture, he wanted to investigate their original materiality "forensically" - which is the archaeological gaze as such. With the arrival of photographies and slide projections, art historical argumentation still had an indexical relation to the physical painting. But its digital scan is not just another "technical reproducibility" in Walter Benjamin's sense, but a complete transsubstantiation of its epistemological essence: its informatisation,

[70] See Ségolène Le Men, Printmaking as metaphor for translation: Philippe Burty and the *Gazette des Beaux-Arts* in the Second Empire, 88-108, in: Michael Orwicz (Hg.), Art Criticism and its Institutions, Manchester (UP) 1994, 88-108

which makes it accessible for the most intelligent mathematical operations on the one hand, and exhaustive manipulation on the other.

There is no metaphysical but strictly technological momentum in the analog-to-digital conversion of material artistic images inherited from the past. With digitization (the sample-and-hold mechanism), a dramatic metamorphosis takes place where hand-made art is transformed into computability. This is not just a further version of the optical camera / art work constellation, but an epistemological *transsubstantiation*. Digitalization can only be a filter of the material work of art, not the indefinite variability of the physical surface (or even essence) - even not by "oversampling". Therefore computational theory nowadays strives for "physical modelling", reconstruction the object from its material basis, its physical "grains" - like the surface of a marble sculpture.

The oblivion of the algorithmic transformation of an art historical image into a mathematical function, from the point of view of media archaeology, is one of the most fundamental blind spots of art historical presentations. If academic art history itself ignores here to reflect its own digital practice, media science has to step in, to be critical of the nature of the digital image in present culture. Therefore *attention*, what is projected from a computer by a beamer or directly online from the Internet, is not the Klimt original in its own materiality, but rather its digital simulacrum.[71]

In juxtaposing, on the computer screen, Gustav Klimt's *Freundinnen* with Tea Nili's pixelized interpretation, what is actually compared is a digital image with a digital image. Not Klimt's painting has been manipulated but its "binary photography", its informational reproduction, its "technical image" in terms of Vilém Flusser.[72] According to Vilém Flusser's media philosophy (Flusser 2011), the alpha-numeric codification of an image is iconoclasm, and at the same time accepting the language of digital economy. The binary "textualization" of a painting transforms it into a formal language which returns with the QR Code (a Barcode) which becomes "readable" by downloading a software scanner, commercially called very appropriately an "Imager", as an "App" on private iPads, iPhones, iPods or an Android Smartphone.

Images can therefore be "read" (deciphered" as texts (character strings), whereas *vice versa* conventional alphabetic texts can be transformed into statistical diagrams which look like images. Thereby a whole printed

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[71] See Jean Baudrillard, Pourqoui tout n'a-t-il pas déjà disparu?, Paris (Les Éditions de l'Herne) 2007

[72] Vilém Flusser, Into the Universe of Technical Images, Minneapolis (University of Minnesota Press) 2011

edition of Immanuel Kant's *Kritik der Urteilskraft* can be compressed into a statistical graph - but this is an image no more but a diagram.[73]

The mapping of an image from the external world onto the memory of a digital camera *via* CCD sampling is already a translation of the physical world into an information which does not even fulfil the criteria of an archival document in its jpg format which is lossy compression. "As a result of radical image decomposition pixels and pixel groups arranged into chromatic colour orders emerge" (Fürstenow-Khositashvii).

The crucial question in digital analytics of cultural images is this: Does such an analysis reveal art historical meaning or rather the message of the machines itself? "The sets of patterns obtained by means of gradual erasure procedure", even if manipulated by the artist Nili by means of Photoshop software, "belong to the order of the machine. It's perception of colour is hypnotic yet dehumanised". "The rhythm of patterns in Nili's photographs [...], the possibility of colour variations is strictly delimited by the software program" (Fürstenow-Khositashvili) which - in the precise sense of Foucault's definition of *l'archive* - governs what can be expressed and perceived. All would be different if the artist became a painter again, "painter" in a second order observation: programming the algorithm herself.

Such is the "surgical" gaze described by Walter Benjamin for the age of photography and film - a "cold gaze" which fascinated Ernst Jünger in his description of reality as well. But what makes it so attractive for the contemporary artists to elementarize and to alter an image by reducing it to the pixel level is not simply any visual artefact but the fact that it is the digital version (the information) of a historical painting. It is the citations from art history, its cultural semantics, which makes its techno-archaeological analysis so provocative.

A new Kind of Transparency? Computer Graphics

The computability of images is a techno-logical recursion of Leon Battista Alberti's and Albrecht Dürer's perspective scale pictures, which have been based upon the rules of projective geometry. The painterly perspective in the Renaissance already subjected the painter's subjectivity to the geometrical construction, as it has been expressed in Dürer's *Underweysung der Meßkunst*. This actually made it possible to calculate pictures out of numbers and rules. A machine can capture an image without any cultural consciousness of the form, by situating the image points in a coordinate system. The apparently continuous image thereby becomes divisible into discrete units; it can be transmitted and reproduced. Most radical has been Sandrart's measuring of the ancient

[73] See Axel Roch, Texte als Bilder lesen, in: online journal *Verstärker*, xxx

Laocoon sculpture group, translating the image from semiotic iconicity into calculable numbers. Expressing pictures by numbers undoes the old dichotomy between image and meta-data; the dichotomy implodes into algorithmicizable space. Once a code is obtained that comprehends images, "[t]his leads one to activate the code and to create new images out of the code language"[74].

The mathematization of the image is not only related to the symbolical order (the numerical), but to the material symbolical machine. In *The Gutenberg Galaxy*, McLuhan links the triumph of Renaissance perspective to the rise of print culture, which correlates the "digitalization" (*avant la lettre*) of the image with the combinatorial machine: the *abecedarium* of the printing press.

The visual display of quantitative or quantifiable information a by-product of Cartesian modernity.[75] Today, the Cartesian coordinate system is programmed into computer graphics software, and often hardwired in the graphic processors itself. The design of virtual objects, in its inaugurative media-archaeological epoque, typically started with a perspectival grid, a conceptual space that would be gradually filled by iconic objects.

With Alberti's "window", and Dürer's *Anweysung zur Meßkunst*, the construction of images has become a geometrical function - the linear perspective. While such operations are still cultural techniques in their direct coupling to the drawing hand and human mind, they become techno-logical in computer graphics.

But media-active archaeology radically goes beyond the concept of "recursion" which is still culturally familiar. 3D graphics is in fact "a critique of the visual bias that dominates most writing on the digital image"; Gaboury therefore expressively decouples computer graphics "from those genealogies of perspective and illusion that so easily contain them"[76]. Different from Lev Manovich's soft "Archaeology of the Computer Screen" which still derives the screen "window" from Renaissance perspective, radical media archaeology is concerned with the techno-epistemic rupture which occurrs in computing, the logical *arché* of the digital image. In accordance with Foucault's definition of *l'archive*, it investigates not the historic origins, but the laws of what can be visually expressed by computation at all. In that sense, the hidden-line, or hidden-surface algorithm posits "an alternate structuring regime,

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[74] Harun Farocki, Reality Would Have to Begin, transl. Marek Wieczorek / Thomas Keenan / Thomas Y. Levin, in: Documents 1/2 (Fall / Winter 1992), 136-146 (142), referring to: Vilém Flusser, Für eine Philosophie der Fotographie, Göttingen (European Photography) 1984

[75] See xxx Tufte, xxx

[76] Gaboury 2xxx: 44

one concerned less with producing an accurate mimesis than with the production of a visual absence"[77] - in fact the infra-visible.

Once they have been digitized into discrete elements of a grey shade, or colour alphabet, images can be visually calculated and internally navigated; instead of forcing the semantic, cultural, or iconological criteria of human image understanding upon the computer. As revealed in machine vision and artificial intelligence, there are entirely different criteria of image similarity, and the "log-icon" (Striano) instead of cultural iconology. Computing induces unexpected image insights *from within* technology, and invites human "vision" to adopt to its inherent techno-logics.

In its analog approach to the visible world, photography once liberated images from being subject to an external symbolic order (textual, alphabetic iconology), in favour of direct optical signals (the physical "real"), and the "coding" by the apparatus itself. This allowed for the analysis (the oscilloscope), and manipulations (the video synthesizer), of the optical signal values. But with the digital approach, images are "addressed" again in the symbolical code, by a second-order alphabet of the alphanumeric. Re-enters the "textual" ratio (Flusser). Digital image processing allows for "meta-dating the image"[78] *from within*.

Digital sampling is not simply a means of communicating images from the "analog" world to computers. This kind of approach to given images sublimely accommodates human image cognition to the logic of computing itself, as a radical alternative to the painterly cultural techniques before. Such digital analysis sooner or later flipped to digital image synthesis. In the case of computer graphics, the visual interface offers a specific transparency to the computational *lógos*, a different kind of revelation of the symbolic which by-passes the supremacy of the optical indexicality, which is familiar from photography or analog electronic imaging. Originary computer graphics does not require an optical source any more, which may then be manipulated, but is a direct function of programming.[79] The "virtual image" is there already, in symbolic latency, just like a piece of music in its score (Adorno's theorem). But in order to become perceivable as a physical image, as event on an optical display, the *lógos* of informational units still depends on material embodiment, and electronic, that is: energetic activation.

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[77] Gaboury 2xxx: 45

[78] The theme of a workshop organized by Lev Manovich on occasion of the DEAF 003 festival in Rotterdam

[79] See Ricardo Cedeño Montaña / Christina Vagt, Constructing the invisible - Computergraphics and the end of Optical Media, in: communication + 1, vol. 7, issue 1 (October 2018), article 2, https://scholarworks.umass.edu/cpo/vol7/iss1/2 (accessed May 17, 2019)

Once a given digitized image is analyzed as mathematical function, in reverse, this invites for synthecizing mathematical functions into "images" directly, with no optical signals needed as a visible source at all. The "image" becomes processual from within computation. Only with electronic, and digital *imaging*, images become "media" in the technical sense of this term.

3D computer graphics, in media archaeological terms, is no (art) historic precursor, but a recursion of conceptual, or "systematic" space in Renaissance perspective (according to Panofsky), which exists prior to the visible objects indeed. Recursion is not simply a time figure of media historiography, but occurs within techno-icono*lógos*.

Benôit Mandelbrot's notorious fractals were not conceived on mathematical grounds; they are not just visualizations of data, or their metaphorization into visible images. The human "insight" into the correspondence between macro- and microscopic processes actually originated from the figurative level on-screen; the computer, as mathematics in being, had an implicit "image" of such "image functions" in advance.[80]

Just like phonographic recording has been replaced by genuine electronic sound generation, in the twenty-first century, genuinely computer-generated images have taken the place of photographies that still refer to an external world. Besides subjecting "analog" sound and images to verbal meta-description any longer, the alphanumerical regime generates audiovisual formats which can be addressed from within their binary (or hexadecimal) code itself, enabling unprecedented orders.

UNMASKING ICONIC INTERFACES. A Media Archaeological "Vision"

The *prosopopoeia* of inter“face“

In a definition of the "interface" in cybernetic terms, humans and nonhumans form a system coupled by interfaces (the HCI model). Radical media archaeology, on the contrary, focuses on interfaces which are operative *within* technology, as strictly defined in electric engineering: its inner-technical levels of analog signal and digital data transfer, ranging from "buses" for bit-wise communication within a microprocessor to the ports for signal exchange with external devices. Extended to software infrastructures, the material interface becomes conceptual again: but not in a phenomenological, but techno-mathematical, logical sense (even if that *lógos* itself does not exist independent of its physical circuitry[81]).

[80] See Heinz-Otto Peitgen / Peter Richter, The Beauty of Fractals. Images of Complex Dynamical Systems, xxx

Persona is the Latin name for a mask, most probably derived from old Greek *prósopon*. Prosopopeia is the rhetorical figure of speech which gives a human face to a nonhuman, inanimate being. The task of media archaeology is to un-mask such anthropomorphising interface techniques, de-metaphorizing the phenomenal surface in favor of their technological "subface" (Frieder Nake[82]), rooting interfaces in their own *internal* reality as technological functions.

Not only humans any more, but machines as well now "interface" to images, in a genuinely techno-logical way. While the media-phenomenological approach is primarily oriented at what humans actually and affectively perceive, media archaeology is epistemically interested in sub-visual knowledge which occurs within technology itself - even if such insights depend on other measuring media themselves, like the oscilloscope or logic analyser for analog and digital signal detection.

In media culture, the term "interface" suggests a predominantly visual display, which renders machine operations visible to humans for communication. Against such media anthropocentrism, the cybernetic science of "control and communication in the animal and the machine"[83] interprets this constellation more inhumanly as a coupling between to equally signal processing systems. Cybernetic casts a cold eye on what is called an interface. In terms of feedback and control, the interface is not simply a performative mediation; it is, first of all (*en arché*), a technical operation, against which the human-machine interaction (HMI) with its graphical user interfaces (GUI) is only peripheral. It is worth remembering the "Glossary" to the glorious Cybernetic Serendipity exhibition catalogue from 1968, dealing with the computer and the arts. The "Interface", here, is defined as "[a]n element of a computer system which connects its constituent parts."[84] The question arises whether human agency is external to computer operations at all; with the concept of the turingmachine, the techno*lógos* of a computing mechanism already incorporates what defines the human as reasoning being.

This de-anthropomorphisation results in an re-arrangement of the familiar order in human-machine communication as mediated by the interface: Media archaeology does not privilege the phenomenal appeare of the "HMC" any more, but focuses on MHC, the machine-human communication, and the machine-to-machine communication itself.

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[81] Friedrich Kittler, There is no Software, in: idem., Literature, Media, Information Systems: Essays, edited by John Johnston, Amsterdam (G+B Arts International) 1997, 147-155

[82] Frieder Nake, Das doppelte Bild, in: Margarete Pratschke (ed.), Digitale Form [Bildwelten des Wissens 3,2], Berlin (Akademie Verlag) 2005, 40–50

[83] Cybernetics, or: control and communication in the animal and the machine, Paris (Hermann) / Cambridge, Mass. (MIT Press) / New York (John Wiley) 1948

[84] Cybernetic Serendipity. the computer and the arts, ed. by Jasia Reichardt, London (Studio International) 1968, 16

Interfaces, in the technical sense, are only marginally designed to address human perception, and rather for infrastructural machine communication.

While the visual interface apparently dissimulates the machine, in reverse perspective from within the machine, it actually absorbs the human into the mechanism, like in computer "action" games.[85]

The term and the techno-social practice of *interfacing* still adhere to an anthropomorphic discourse, with its focus on communication between man and machine. A media-archaeological understanding of "interface", though, liberates machines from such rhetoric, separating metaphorical interfaces from its technical functions, by deanthropomophising technical media from the ways they are being *personalised*. As a technical term in engineering, the "interface" describes the precise scenes and moments of coupling between two technical systems. Its purest form is not the performative "interface" of computer screens, but operations *within* computers, where internal logical "interfaces" such as compilers, among other configurations, constantly mediate between its hard- and software, and its processing and intermediary storage levels. The interface is not only "ultimately something beyond the screen"[86], but below the screen as well. The compiler of a higher programming language is software itself, functioning as *internal interface* already, allowing for a communication between symbolic source code, machine language, and the electrophysical logical gates themselves.

The basis for "digital" visual interfaces is the alphanumeric code - even if it is masquerading in the guise of images. The criminal archive has long resided on photographic portraits of delinquents or of collected fingerprints. The iconic or indexical paradigm nowadays is *dataveillance*. Even if these data sets are still phenomenally generated as „images“ on interfaces (computer monitors), they can hardly be called „images“ any more. The identification of some 2200 victims of the World Trade Center attack could only succeed by comparative DNA analysis, in order to be able to literally sort (or assemble) 14.000 found fragments of corpses. When the faces are destroyed, they are being replaced by the data "mask".

Interface *versus* "subface"

While culture has developed a series of techniques which extend human mind and body action, media archaeology focuses on the disruptive *dis*continuity between such cultural techniques and truly techno-logical

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[85] See Claus Pias, Computer - Spiel - Welten, Munich (Sequenzia) 2002
[86] Alexander Galloway, Interface Effect, Cambridge (Polity Press) 2012, esp. chap. 2 "Software and Ideology", 54-77 (54)

devices.

Every screen is not transparent, but a shield, actually hiding its material, technical or logical infrastructure, by "showing". The task of media archaeology thus is an act of un-covering. Human media perception, starting with the film screen, the analog TV and video monitor, and resulting in the digital screens, is based on surfaces everywhere. These surface phenomena, though, can not be opposed to a hidden interior, since no semantic depth is intended. They are what they show. When computation renders data for visual display, this is not a metaphorical, but a diagrammatic enunciation and "presencing" of its technological *scheme* , its "insight" (even when the rules and chains of signal transduction are not transparent to the external observer). To what degree does the digital interface make the operations of the machine visible to the human user? Or does the differentiation between a "sur-" and a "subface" (Frieder Nake) fall victim to a metaphysical dichotomy?

From visual interfacing to *monitoring data*

Radar once extended visual perception beyond the optical horizon, while at the same time reducing it on decisive data identification and control. Otherwise imperceptible electromagnetic impulses are represented by the cathode ray tube visually, just like it happens with radio reception acoustically, thus establishing an interface between the electromagnetic regime, and its human interpreter. With digital media, such signals become data. Complex data clusters, when represented in abstract symbols and data strings, can hardly be comprehended by human reading any more which is too slow. For the sake of human understanding, they are being abridged by "visualisation" into images. Knowledge and seeing converge, both etymologically and in the act of decoding. The early design of a visual interface called *Dataland* in 1973 (William Donelson) resulted from the wish to create a multi-media data bank where information could be spatially processed and retrieved - without using keywords or logic or relational criteria. On the computer screen, this was achieved by a virtual surface with visual symbols (icons) representing different forms of data quantities.

Visual and sonic navigation in dynamically generated information landscapes are central tasks for multimedia designers. But do interfaces necessarily require audio-visual orientation, or is a mathematical interface thinkable, as envisioned by Leibniz - interfacing knowledge in logical space?

The media art collective Knowbotic Research (KR+cF) devised a knowledge space to represent the Antarctis, a model of a Computer Aided Antarctica. The installation limited the material to the available computer-processed information on current antarctic research as it

appears in public data networks, and "gave rise to phenomena which are difficult to conceptualize - a Computer Aided Reality"[87]. Knowbots were the devices "operating as spatially and temporally dynamic interfaces for the observer's interactive navigation through the information landscape."[88] The Antarctis as data pool actually happens outside the Antarctis, as artificial nature in data representations of measuring and sensoring instruments covering this area and procuding, every second, a stream, a flood of data (like satellite vision). These informations tend to become independent and can be grasped and administrated only by "ar(c)tificial" intelligence agents (learning algorithms, so-called knowbots) in computer networks. These agents, in the mentioned installation, create images out of the flood of information from the south pole. The data body of this Cyber-Antarktica is based on temperature data and Ozone values - scientific material which has lost any deep sense or semantic meaning, thus rather equalling the Shannon- than the cultural studies-like notion of communication. The visitor moves in visually interactive data clouds instead of fixed interfaces: "Our installation 'Dialogue with the Knowbotic South' [...] is based on knowbots, which generate a vision in a data-network. They originate a hypothetical nature, a Computer Aided Nature (CAN). [...] We have designed a visual form for every knowbot's algorithm corresponding to the data sets. [...] We do not have an interface any more, a mechanical interface, in the real world, we have interfaces in the network, the dynamic network."[89]

Temporal Interfacing

Before the video monitor functions as an interface of the magnetic tape to human perception, there has been the camera as interface between the optical event and its electronic recording by analog transducers. In digital video recording, the scan lines as time signals have become divisible into computational bits by sampling and quantification. "Transforming the signal into numbers, recording them into memory, recalling them at the right moment, and transferring everything errorless back to the analog signal first appeared in 1974 in the Ampex AVR-2 recording facility"[90], allowing for time-critical adjustements of the electronic image by the digital Time Base Corrector.

analog electronic screens, in the sequential unfolding of the cathode rays, have been time-images already. The computer terminal is not only

[87] Blast 1996; http://www.krcf.org/krcfhome/1dwtks1.htm
[88] Ibid.
[89] Christian Huebler, in: Paolo Atzori, Discovering CyberAntarctic: A Conversation with Knowbotics Research, http://www.ctheory.net/text_file.asp?pick=80
[90] As described in the special exhibition on 60 years of television in the National Technical Museum, Prague, fall / winter 2013

monitoring, but actually interfacing computing time. Images, symbols, data, points and pixels which appear on the present time window of the monitor and disappear as fast, sink back to the memory, from where they can be re-called every moment into a ever repeatable re-presentation. Once quantified, time is fragmented, becoming divisible into smaller and smaller usable bits.

When coupled to technical media interfaces, humans are placed in temporal situations that differ from experiences of previous times. So-called interactive interfaces actually hide the micro-times of internal computing which are the precondition for the "realtime" effect to human perception. If the intraface is a "'zone of indecision' between the inside and outside"[91], the "real-time" window of computational processes is its temporal equivalent, a zone of decisions which unfolds as an extended present from the immediate past to the anticipated future (pro- and retention, in Hussler's phenomenological terms).

Users of the operating system UNIX, by applying the order HISTORY, can re-call a chronicle of terminal events, providing for temporal transparency. The *RAND Corporation*, in trying to automatise military simulation games, even created the term *synthetic history*.[92]

The monitoring of programs in execution by visualising tools such as the Brown Algorithm Simulator and Animator (BALSA) can lead to immediate non-symbolic interaction with the program observed, e. g. by means of a light pen (Ivan Sutherland's Sketchpad), and thus advance from simply displaying algorithms to actually control it in execution. Such a software provides facilities for displaying insight into the temporal nature of computing, when its data structures are updated simultaneously during the program execution, and thereby privide kind of a motion picture of the algorithm in action. This results in interfacing the chronological unfolding of data processing: "BALSA could replay its saved history of interesting events and the view would update itself incrementally as if the program were executing"[93], for a kind of analysis which is interested in what happened in the algorithm over "history" rather than the current state.

An alternative to the visual interface which actually hides its underlying software operations is "live coding" as a kind of dynamic interface. This not only allows for monitoring the execution of an algorithm directly on

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[91] Gérard Genette, Seuils, Paris (Édition du Seuil) 1987, 8, as quoted in Galloway 2012: 40

[92] See Claus Pias, Synthetic History, in: Archiv für Mediengeschichte, Weimar (2001), 171-183 ; online Version https://www.uni-due.de/~bj0063/texte/history.pdf (accessed September 2017)

[93] Marc H. Brown / Robert Sedgewick, A System for Algorithm Animation (1984), reprinted in: Ephraim P. Glinert (ed.), Visual Programming environments: Aplications and Issues, IEEE Computer Society Press 1990, 119

the "shell" level of code lines, but in the cybernetic sense of communication invites for immediate feedback + control by direct alteration of the code itself in real-time.[94]

Computer Analphabetism?[95] Iconic Interfacing

Icons are functional pictures created by computer graphics for interaction on the media scene of the man-machine interface. In pre-modern times, images as *ikones* communicated to the illiterate. Such icons have returned on the computer screen. Umberto Eco, in his essay „MS-DOS is Calvinistic“, opposed the (nowadays prehistoric) MS-DOS interface user to the Apple Macintosh User, mirroring the schism between catholicism and protestantism in Christian religion. The Calvinist version is concentration of information on the alphabetic script, equalling code listing, while the Catholic version is counter-reformation by iconicity.

Civil use of computing resulted in the creation of interfaces as user illusions. "At PARC we coined the phrase 'user illusion', to describe what we were about when designing user interface", Allan Kay confesses in his essay „User Interface: a personal view“. Neither visual properties nor similarities can guarantee the appropriate understanding of an icon, but their advantage is that they suggest to the user who might be completely ignorant of machinic procedures the option of directing the machine. Thus icons fulfil the traditional task of transfering coded commandments to persons who don't know this code. What is the alternative? Transforming passive users into active programmers? Even source code is a symbolic representation of computing already. Icons themselves might become a form of knowledge, as practiced in scientific techniques of visualisation. The „black box“ of computing, its hardware, might be iconised down to its most minute register, making the central operations of the processors visible, transparent.[96]

Even in computer programming, the icons have taken over: "In HI-VISUAL, objects which the system deals with such as data and program are represented in terms of icons. Programming is carried out simply by arranging icons on the two-dimensional display screen and specifying flow of data."[97] The icon here bears resemblance with the coding as a kind of visual short-cut of algorithmic lines.

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[94] See Charles Roberts / Graham Wakefield, Tensions and Techniques in Live coding Performances, in: Alex McLean / Roger T. Dean (Hg.), The Oxford Handbook of Algorithmic Music, Oxford / New York (Oxford University Press) 2018, 293-317

[95] See Vilém Flusser, Die Auswanderung der Zahlen aus dem alphanumerischen Code, in: Dirk Matejowski / Friedrich Kittler (eds.), Literatur im Informationszeitalter, Frankfurt a. M. / New York (Campus) 1996, 9-14

[96] See Stefan Heidenreich, Icons: Bilder für User und Idioten, in: Birgit Richard / Robert Klanten / idem (eds.), Icons - Localizer 1.3, Berlin 1998

Clickable icons, programming-as-writing and the simulacricity of interfaces may coincide, when it comes to *visual programming*. Iconic programming environments make diagrams (or pictograms, graphical notations) transitive: they do, what they metaphorically indicate, thus being metaphorical no more in a rhetoric sense, but in a technical meaning of data transfer. If icons are not reduced to an image which is displayed on the screen but accompanied there by the functional description associated with it such as a program code and a data value[98], they are not just small images on a display to visually assist the communication between user and machine, but become conceptual objects. The icon thereby bears resemblance with the coding as a kind of visual short-cut of algorithmic lines. But the ways images are being processed in the human brain fundamentally differs how they are algorithmically generated from within the computer: "An image is captured as a whole. It is processed in a parallel manner, and the semantics are entered into long-term memory. [...] The speed of image processing and the accuracy of image recognition are two factors on which an iconic-based man-machine interface can capitalize."[99] But icons may be much more culturally ambiguous than the mathematical codes they dissimulate. Is a virtual machine like the BALSA a simulation or an actual performance of such proceedings?

Towards an Interface Aesthetics of Enhancing the Difference between Man and Machine

Against industrial ambitions to suggest a smooth human-computer interaction (HCI), visual interfaces might rather enhance the difference between human perception and machine operation. J. R. Licklider, in his seminar 1960 paper on "Man-Machine Symbiosis", did not address humans and machines as being intellectually equivalent beings, but as fundamentally different in their cognitive capacities. While humans, though being "noisy, narrow -band devices" from an communication engineering perspective, are better at intellectual activities requiring parallel processing, electronic computers have advantage in terms of precision, memory capacities and speed of data processing.[100] Licklider therefore proposed an asymmetric tight coupling of human brains and computing machines. "For Licklider, a promising existing example of this symbiosis was a system of computers, networking equipment, and

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[97] Tadao Ichikawa / Masahito Hirakawa, Visual Programming - Toward Realization User-Friendly Programming Environments [*Proceedings 2nd Fall Joint Computer Conference, 1987, 129-137], in: Glinert (ed.) 1990, 59-67 (59)
[98] Ibid., 61
[99] Kenneth N. Lodding, Iconic Interfacing [*IEEE Computer Graphics and Applications, Vol. 3., No. 2, March/April 1983
[100] J. C. R., Licklider, Man-Computer Symbiosis, in: IRE Transactions on Human Factors in Electronics. HFE-1 (March 1960), no. 1, 4-10

human operators known as the Semi-Automatic Ground Environment (SAGE) that had opened two years earlier to track U.S. airspace."[101]

Many approaches to "new media" emphasise the phenomenal side of screen perception, in its orientation towards human audio-visual senses. Media archaeology, on the other hand, asks (with McLuhan) to what degree "the medium is the message". It concentrates on the screen where it is indexical of the machine itself. Instead of conflating the visual interface as "medium" with actual image processing, blindness to the visual appearance is the condition for a different kind of rather epistemic than visual "insight" into the technical essence of the so-called "visual" media.

Is the interface a medium, mediating between technological inside and phenomenological appeal? Aristotle identified *to metaxy*, literally the „inbetween“, and in its Latin translation the *medium*. It becomes obvious only in moments of breakdown: "Objects and properties [...] arise only in an event of breaking down in which they become present-at-hand. [...] A breakdown is not a negative situation to be avoided, but a situation of non-obviousness, in which the recognition that something is missing leads to unconcealing [...]. This creates a clear objective for design - to anticipate the forms of breakdowns and provide a space of possibilities for action when they accur."[102] The interface can become a zone of conflict; only irritation reveals the technical medium to the human senses.

But commercial human-machine interfaces tend to erase the human-machine difference by creating the illusion of an immediate "dialogue"; the alternative interface aesthetics is confronting the differences. Interface design tends towards the oblivion of hardware by software operations, in order "to break free of the computer, to break free conceptually. [...] Cyberspace is unlike any physical space. The gravity that holds the imagination back as we cope with these strange new items is the computer itself, the old-fashioned physical machine. [...] every key step in software history has been a step away from the computer, toward forgetting about the machine and its physical structure and limitations – forgetting that it can hold only so many bytes, that its memory is made / of fixed-size cells, that you refer to each cell by a numerical address."[103]

Insight into Electronics: The Video "Image" as a Function of the Thermionic Tube

[101] Oscar Schwartz, Untold History of AI: The DARPA Dreamer Who Aimed for Cyborg Intelligence (entry April 8, 2019), https://spectrum.ieee.org/tech-talk/tech-history/dawn-of-electronics/untold-history-of-ai-darpa-dream-of-cyborg-intelligence, accessed May 16, 2019
[102] Winograd / Flores 1986: 36 u. 165
[103] David Gelernter, Machine Beauty, New York (BasicBooks) 1997

The thermionic tube is a central agency in electronic media, if it is not reduced to its external appearance of the literal "tube" as visual interface in the form of television monitors and computer terminals. It began its mass media career as a radio signal amplifier, but as a picture tube, it is the only instance of an "internal" electronic element which becomes a human-machine-interface as the same time.

[Fig.: "Magic Eye", a thermionic tube for displaying signal quality on a phosphor screen inside, from: Media Archaeological Fundus, Humboldt University, Institute of Musicology and Media Studies]

The drama of actual encounters between technological knowledge and physical matter (electric engineering) unfolds in the micro-media theatre of the video tube. This device ahistorically preexisted *avant la lettre* - the "Edison effect".

Thomas Alva Edison rather accidentally experienced electrons becoming visual the moment when his object of experimentation, the evacuated glass bulb, sublimely produced what later became known as the Edison effect: a shade of colour produced by the electron flow at the anode end of the evacuated glass bulb, like a first video or TV "image" *avant la lettre*. Sometimes technological objects have implicit knowledge even before any human even has an idea of its meaning and use. Instinctively, Edison made sure that this phenomenon which he had observed in 1875 and refined in 1883, while trying to improve his new incandescent lamp, got patented. But this is not media phenomenology at all, but electrons in action. In a vacuum, electrons flow from a heated element - like an incandescent lamp filament - to a cooler metal plate - the classic example of thermionic emission.[104]

Different from katoptic film screen projection, the luminosity of the electronic cathode ray tube comes from within an electronic device and invites for its media-archaeological inspection, tracing back the electronic "image". In video and television, a core electronic unit which for other media remains hidden behind the interface, became an interface itself.

A visual computer interface does not necessarily hide its computational essence; whatever appears on monitor, actually might be a direct enunciation or function of algorithms and codes, just a different mapping in electronic transduction or symbolic transcoding. Such an immediacy is known from "analog" television. The television screen has been a media scene for critical interface experimentation: "Everyone should have as many controls as possible to permutate the size, shape, and color of what they're watching. [...] generally they're offered to "adjust" a picture which is thought to be abnormal, rather than to create your own

[104] https://en.wikipedia.org/wiki/Thermionic_emission, accessed October 2, 2017

electronic kaleidoscope. However, one thing you can do is draw a magnet across the face of the picture tube. This messes with the magnet field on the picture tube and distorts the image (without damaging the set) at your control."[105]

A Functionally Hidden "Visual" Interface: The Williams Tube

The Technische Sammlung Dresden houses an archaic demonstration computer with arbitrarily slowed-down data cycles. Here, flashing light bulbs are not metaphoric but indexical, embodying the charge of one bit each. On a pixelled Commodore 64 computer screen, the graphic image has been a direct emanation from bit distribution within the internal RAM.

The "Williams tube" in early electronic computing did not visualise, but actually incorporate dynamic data storage, as an implementation of electronically stored-memory programs. Such codes were "seen" only by the machine.

[Fig.: Still from Williams tube program display, as applied in the Standards Western Automatic Computer (SWAC), from: https://en.wikipedia.org/wiki/Williams_tube, accessed July 25, 2019]

The Williams tube makes use of an electronic defect which is technologically converted into a short-time memory effect, known as secondary emission that occurs on cathode ray tubes. "When the electron beam strikes the phosphor that forms the display surface, it normally causes it to light up"[106] - which is all the sense of the TV, oscilloscope, or video monitor. "However, if the beam energy is above a given threshold (depending on the phosphor mix) it also causes electrons to be struck out of the phosphor" (ibid.). This *invisible* effect can be used to write, or read, a charge which is equivalent to one bit, or its combination into a binary "word". Such memory functions were possible exactly by hiding the glass display to human viewers. In order to function as a condenser for short-time data storage, the tube was covered by the pickup plate. "If a visible output was needed, a second tube connected in parallel with the storage tube, with a phosphor coating, but without a pickup plate, was used as a display device"[107], which is the familiar video oscilloscope for the visual monitoring the same operations. Visual media interfaces, addressed to humans, are a second-order observation already.

Is there an Indexicality of the "Digital" Interface?

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[105] Shamberg & Raindance Corporation, Guerilla Television, 1971
[106] Entry "Williams tube", https://en.wikipedia.org/wiki/Williams_tube, accessed July 25, 2019
[107] Wikipedia entry "Williams tube", op. cit.

An electronic computer terminal does not reflect an external mechanism of light projection like the cinematic screen, but it is a "transparent threshold"[108]. Does such an interface dissimulate its technical truth which unfolds within the computing device? According to Friedrich Kittler, with digital computing, "[s]ound and image, voice and text are reduced to surface effects, known to consumers as interface. Sense and the senses turn into eyewash. [...] Inside the computers themselves everything becomes a number: quantity without image, sound, or voice."[109] But maybe such an interface is not intransitive to the hidden mechanism behind, but transitive to its very operations. It does not simply translate signals or information from computer hard- and software to visibility, but gives insight to its internal states, in a special kind of indexicality of the digital.

The early C64 computer game images have been a direct *outsourcing* of the RAM chip; the computer monitor is not simply translating information from computer hard- and software to human visibility, but actually displays the message of its internal data processing.

The most radical "digital" interface is when the output signals are the externally visible "indication of the internal state"[110], just like in early electronic computing the proverbial "tube" as a visual interface displayed signals as a direct function of the thermionic tubes which were coupled to flip-flop circuitry inside.

On the computer screen, all space becomes a concretization of computational diagrammatics, a function of an abstract algorithm. At the *arché* of digital computing, there is interfacing to the external signal world by translation already, the transformation of physical reality into coded data (that is, whatever can be „read“ by the computer). The world is abstracted into binary values (embodied as voltage); whatever cannot be translated into numbers, literally *does not count*.

The algorithmic indexicality of the digital image provides for an insight into the image as information, as it occurs within data processing. In order for the digital sublime to become sensible, information needs to be incorporated by interfaces. Against the metaphysical dichotomy of the visible and the invisible, the surface and the hidden, the digital interface always reveals a structure from and within the computing device.

Interfacing as metaphorisation / translation

[108] Galloway 2012: 25

[109] Kittler 1999: 1

[110] Alan Turing, Computing Machinery and Intelligence, in: Mind, New Series, vol. 59, No. 236 (1950), 433-460, section 5 ("Universality of Digital Computers")

The optical terminal of a computer is an interface for communication between human and machine which on the signal level transduces, and on the cognitive level translates, between different layers of representations. However, also parts of software are interfaces which allow for communication between two or more programs written in different languages. In contrast to the hardware case, the software-to-software interface can not be physically, only logically be localized. It is no phenomenal appearance but the functionality that defines this coupling as an interface.

"A computer monitor [...] is a cascade of interfaces that transforms internal electromagnetic states via data buses, oscilloscope, fluorescent material etc., to electro-magnetic states in the visual range of wavelengths. A purist may write down a differential equation of the whole thing on a microscopic level where the notion of an interface seems to become rather arbitrary. It seems, that the intuitive notion of an interface is a relativistic concept."[111] Even the present "now" is nothing but a cognitive interface for the integration of different temporalities.

Interactive interfaces

Most man-machine interfaces as instruments were built to deceive the eye. "The new dispositives will deceive the brain. For that new interfaces have to be developed [...]."[112] In military action, smart bombs that interactively check observations of the terrain against a stored map of their routes are called "smart" since they are able to enhance algorithms with interaction, while traditional linear algorithms are metaphorically "blind" because they can not adapt interactively while they compute.[113] The 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 [...]."[114] The concept of "life coding" actually allows for dynamic human-machine interaction on its operative, not metaphorical level "on the fly", during exection of the program itself.

Transitive interfacing

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[111] Hans Diebner, "Preface", in: idem / Timothy Druckrey / Peter Weibel (eds.), Sciences of the Interface. Proceedings of the International Symposium *Sciences of the Interface*, Tübingen (Genista) 2001

[112] Peter Weibel, director of the ZKM - Center for Art and Media Karlsruhe, Germany, on *The Art of Interface Technology*

[113] Peter Wegner, Why interaction is more powerful than algorithms, in: Communications of the ACM, vol. 40, no. 5 (May 1997), 80-91 (82)

[114] http://www.computerhistory.org (accessed June 6, 2008)

In *Alice in Wonderland*, the protagonist jumps down into the looking-glass room. The ultimate interface would be the abandonment of interfaces, the immediate sending of sensual data from computer to human senses or nerves: no simulation any more, but cerebral stimulation. As opposed to traditional *mimesis* (mirroring reality), such an interface *generates* (virtual) realities.

When compared with most traditional physical interfaces, which remained relatively stable over long periods of time (like the book page), the digital (virtual) interface is uniquely open to reconfiguration and radical redesign. Current interface design still metaphorically (or iconically) mirrors or "re-mediates" (Bolter / Grusin) the old media aesthetics (following McLuhan's law), like the „folders“ in current windows still conservatorily mirror the bureaucratic, archival paradigm of administering knowledge, new forms are genuinely information-based. As long as the keyboard of computers is alphabet-based like a type-writer for printing just letters, the paradigm of printing remains dominant. The notorious Turing test, as described in 1950[115], still required an electro-mechanical interface between man and machine, a teletaper, since direct coupling between man and machine has not yet been possible.

Just like the media theoretician professor O'Blivion says in David Cronenberg´s movie *Videodrome*: The electronic image from the screen is mirrored by the retina of our eye and can be transferred from there to the computer screen. Electronic signals invade bodies by the very physical act of perception. Telematic communication has already generated depersonalized forms of interfacing. When the human is tightly coupled into the system circuitry, the interface is looking back in terms of feedback - like the Iris scan, and eye-tracking camera software. All of the sudden, the interface is within the system itself. The future will be the transition from exterior to interior interfacing, while the term „immersion“ indicates the dissolution of the interface as such. The dialogical model is replaced by the immediate.

Imaging **in the "Age of the World Picture"**

"Vision" from within, and between technologies, does not need an optical interface any more. 3D object recognition is realised by sensors, rather mapping than *imaging*. Interfacing thus transforms from intransitive (literally "not passing over") to transitive communication. This is communication with no optical interface any more, rather an act of symbolical recording and archiving, e. g. the biometrical data (fingerprint) on computable passports. Technically speaking, "telematic" communication (Vilém Flusser) has generated depersonalised forms of

[115] Alan Turing, Computing Machinery and Intelligence, in: Mind, Bd. 49 (1950), 533-460

interfacing already; partners of communication have become signals and ciphers of addresses.

The ultimate sub-visual interface are sensors that translate optical signals into the symbolic regime of computability, as embodied in the analog-to-digital converter. In digital machine vision, which is phenomenology in the media-active sense, the modern "Age of the World Picture", which has been identified by Martin Heidegger as the epoch of a numerical measurement approach to the physical world, is literally enacted as *imaging*. Different from image anthropology and the anthropocentric focus on the screen as visual interface between the machine and the human, media archaeology attends to the encounter of "image" and machine itself, thereby returning to the original technical meaning of "interface" as system coupling.

Algorithmicized Image Retrieval:

TOWARDS AN IMMEDIATE LOGICAL ACCESS TO DIGITAL IMAGES

A visual archive of cinematograpical *topoi*: Navigating images on the borderline of digital addressability

What the digital matrix allows for, is the option of navigating images *within* their own medium - without changing from visual to verbal language. The task of *searching images* does not only mean searching for images, but has a second, reverse meaning as well: sample image that are capable of searching for similar images, without the interception of words, navigating in *Dataland* (as designed in 1973 by William Donelson), not meta-dated by the alphabet.

In most media archives, navigation through image repositories depended on their meta-data, tagging images by verbal description. Addressing and sorting non-scriptural media remained an urgent challenge which, since the arrival of fast-processing computers, could be met by digitizing analog source material. The result is not necessarily better image quality but, rather, the unforeseen ability to directly address not just images (by frames) but every single picture element (each pixel) - just like *our body has become a genetic archive*, now that it has been digitally opened up in the Human Genome Project.

Images and sounds have become calculable and thus capable of being exposed to pattern-recognition algorithms. The notion of „pattern“, after all, is derived from Latin *pater* - no matrix but rather a patrix, a patri-archival order (as described by Derrida in his book *Archival Fever*). 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 meta-data but according to its proper criteria - visual memory in its own medium (endogenic).

Contrary to traditional semantic or iconological research in the history of ideas, such an endogenic visual archive will no longer list images and sequences according to their authors, subject, and time and space of recording. Instead, digital image data banks will allow visual sequences to be systematized according to genuinely iconic notions and mediatic rather than narrative common-places (*topoi*), revealing new insights into their im/material values. Predominantly scripturally-directed culture lacks the competence of genuinely visual communication; the writer Arno Schmidt envisioned of a box that would make it possible for him to immediately communicate with the visual memory apparatus.

Visual archiving: Sorting and storing images

Pixel by pixel, visual archiving is all about both *sorting* und *storing* images - the archival question.

Cultural memory of images has traditionally linked images with texts, terms and verbal indexes. Confronted with the conversion of images into digital storage gradually non-verbal methods of classification gain importance. It is not the archival question which poses a problem to visual memory; rather the search methods used to find pictorial information are still limited to models which habe been developed for retrieving texts: "Typically, available methods depend on file Ids, keywords, or text associated with the images. [...] they don´t allow queries based directly on the visual properties of the images, are dependent on the particular vocabulary used."[116]

Techno-image archaeology[117] aims at rethinking the notion of images from the vantage point of the process of digital archiving. The archive here is seen as a form of organization of all that can be addressed as information - in so far they determine as well what is allowed to be forgotten.

Cybernetically read, an archive is a coupling of storage media, formats of contents and address structures. In this case the images is to be conceived as data format. Methodologically this implies leaving behind the contemplation and description of single images in favour of an investigation of sets of images.

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[116] Flickner et al. 1997: 7

[117] On technical images and the notion of the techno-imaginary, see: Vilem Flusser, Kommunikologie, ed. Stefan Bollmann / Edith Flusser, Frankfurt/M. (Fischer) 1998

Returning to Lessing, his 1766 essay *Laocoon or the Limits of Painting and Poetry* discusses the aesthetic conflict between the logic of language and the logic of images in terms of a genuinely muli-media semiotics: painting (*pictura*) is no longer – as declared by Horace – like poetry (*ut poiesis*); time-based media (like dramatic speech and linear narratives) differ from space-based media (like simultaneous two-dimensional pictures). The digitalization of images today provides a technical basis of inquiry into this conflict in terms of the medium computer. How can archives be related to algorithms of image processing, of pattern recognition and computer graphics? Wavelets instead of Fourier analysis?

Paradoxically, metadating blinds its images. Western cultural competence and technology of finding, transferring und processing stored images has been marked by the supremacy of the word as instrument and medium of control and of navigation, such as catchword translation of image contents and the titling of authors and works - a practice which media philosopher Vilém Flusser calls „Iconoclasm“. Iconography is the essence of a text-based grip on images (comparable to Optical Character Recognition), trying to reduce the informational richness of an image to the clarity of verbal semantics.

In sharp contrast to iconography the media-archaeological investigation of image archives do not take images as carriers of verbally expressable meanings. Image processing by computers can no more be re-enacted with the anthropological semantics of the human eye. The starting point is rather a theory based on Michel Foucault´s discourse analysis and Claude Shannon´s mathematical theory of communication, as well as practices and notions of data-structure-oriented programming. A meta-data-free visual memory leads to intuitive visual archives: *modelling* similarity without verbal annotation; instead: query by visual (ex)sample, automatic feature extraction. This model does not replicate human behaviour but media-archaeologically performs data mining. Just throw an image into the computer and see how the computer, orders it - which, finally, might teach humans to take the perspective of computer perception (for a moment at least).

There is no necessity to force the semantic criteria of human image understanding upon the computer. On the contrary, the entirely different criteria of image similarity in computing may leed to unexpected insights in visual culture. Beyond meta-dating, images can be approached in their own technical terms - an interfacing aesthetics based on the difference between human and machine.

The hunger for visual knowledge in the - literally - age of enlightenment led to visual encyclopedias in the eighteenth century already (like the *planches*, i. e. the visual supplement of the big French *Encyclopédie* edited by Diderot and d'Alambert). Photography then has been the

switching from printed imagery to genuinely automated visual technology, resulting in the first technical image archives.

Without meta-data, thought, the human mind gets lost within the imaginary museum (André Malraux) of photographic pools. The alternative to the photographic encyclopedia is visual sampling.

When it comes to programming digital data bases, priority should be given to the development of a *visually* adressable image archive by the application of de-ferring algorithms creating different visual sequences and neighbourhoods (the digital *différance*). Operators of image processing and pattern recognition such as filters and invariant transformations can be integrated in the structure of the data-base in order to make cluster of images accessible by pixel data within, not outside the pictures. Let us have a look at such an image-based image retrieval program developed by the VIPER group at Geneva.[118]

Navigating the visual archive: moving image retrieval

Retrieval is possible only by adressing the image data by an index - *via* an archivial register, metadata. In art historical museums and other kinds of image collections, not the images, just their alphanumerical meta-data belonged to the realm of the archive. There are two divergent, even conflicting archival info-aesthetics.

Instead of endlessly re-arrangable photographic image collections, movies themselves have become the image archives in media culture, ruling image sequences both conceptually (*montage*) and consequentially.

Within the medium film, the practice of montage (*cutting*) has always already performed an kind of image-based image sorting (by similarity, f. e.). Cutting has two options: to link images by similarity of by contrast (Eisenstein´s option). Only video – as a kind of intermediary medium between classical cinema and the digital image – has replaces mechanical addressing of cinematographic images by different means (*timecode*), offering new options of navigating in stored image space. Automated digital linking of images by similarity, though, creates rather unexpected, improbable links: which are, in the theory of information, the most informative, the least redundant ones. It also allows for searching for the least probable cuts.

What happens if that sequence is not being arranged according to iconological or narrative codes any more, but rather in an inherently

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[118] *Online-Demo* http://viper.unige.ch/demo/php/demo.php

similarity-based mode, leading to a genuinely (image- oder media-)archaeological montage?

Every film camera shot is already a sequence of images (photographic frames) which, until the cut, is characterized by image similarity. If an image (frame) is thrown into the digitized film images pool, an algorithm is able to contextually detect the most probable shot it is derived from. Once large quantities of film have been archived, such an automatized query will uncover patterns of similarity which human, that is: iconologically-centered image perception (imagination) would not even conceive of - an archive of *signifying* (not signified) *topoi* such as colour distribution patterns and historgrams which are not being externally defined by man (by meta-dating), but inherently by the digital nature of the scanned images themselves, that is: my media-archaeological self-awareness.

Different from the verbal space there is still an active visual thesaurus and grammar of linking images lacking; our predominantly scripturally directed culture still lacks the competence of genuinely filmic communication („reading“ and understanding).

Criteria for storing electronic or filmic images have been listed by the director of the Federal Archives of Germany (Kahlenberg) and the chief archivist of the nationwide public TV channel ZDF (Schmitt); next to economically driven recycling of recordings and historical or political aspects follows, under "gestaltungsbezogene bzw, ästhetische Kriterien": l. „Optische Besonderheiten“ (remarkable camera perspectives, such as „Bildverkantung und extreme Auf- oder Untersicht“), 2. „die dramaturgische Gestaltung von Bildsequenzen“ (cut, opposition of single frames), 3. „besondere Bildmotive“ (landscapes, people) – close to Farocki´s *topoi*. Last but not least, of course, „Medientypische Gesichtspunkte“ – the very proper media-specificity, such as a memory of the TV channel itself.

In the marketplace, however, digital video browsing still seeks to reaffirm textual notions such as the story format as segmentation of a video sequence, such as the news story, „a series of related scenes with a common content. The system needs to determine the beginning and ending of an individual news story."[119] Beginning and end though, in technical terms, are nothing but cuts here.

With film, time enterns the pictorial archive. Once being digitized, even the single frame is no more a static photographic image, but a virtual

[119] Alexander G. Hauptmann / Michael J. Witbrock, Informedia: News-on-Demand Multimedia Information Acquisition and Retrieval, in: Mark T. Maybury (ed.), Intelligent multimedia information retrieval, Cambridge, Mass. / London (MIT) 1997, 215- 240 (226)

object which is constantly being re-inscribed on the computer monitor in electronic refresh circle light beams. While the visual archive has for the longest time in history been an institution associated with unchangeable content, the memory of (time-based) images becomes dynamic itself. Thus, images get a temporal index.

„Current video processing technologies reduce the volume of information by transforming the dynamic medium of video into the static medium of images“; that is, a video stream is segmented and a representative image is extracted[120] - exactly what indexing by words (description) does.

"Retrieval and browsing require that the source material first be effectively *indexed*. While most previous research in indexing has been text-based (Davis 1993, Rowe et al. 1994), content based indexing of video with visual features is still a research problem. Visual features can be divided into two levels: low-level image features, and semantic features base don objects and events. [...] a viable solution seems to be to index representative key-frames (O'Connor 1991) extracted from the video sources."[121]

But what is "representative" in that archivo-archaeological context? "Key frames utilize only spatial information and ignore the temporal nature of a video to a large extent"[122] - which is exactly the boundary between the iconological and the archaeological gaze, between semantics and statistics, between narrative and formal tropes. Would a visual dictionary still follow the print-model of alphabetic, lexicological order, or does it rather make sense to concentrate on syntax, thus treating semantics as second-order-syntax?

Search & Destroy: *Eye / Machine*

In automated systems, the image is meta-dating itself; the meta-data are *within* the image already. In his film series *Eye / Machine*, Harun Farocki directs attention to the *operative images* in so-called "intelligent" weapons that become data-driven by matching images, not by meta-data any more. That is why Farocki does not link the sequences of his films by massive verbal commentaries any more, but the self-linking of images itself mirrors the technology that is the subject of his film - which in the meantime has become driven by algorithmic research. Visual knowledge has become digital nonhumanities.

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[120] Atsushi Takeshita / Takafumi Inoue / Kazuo Tanaka, Topic-based Multimedia Structuring, in: Maybury 1997: 259- 280 (259)

[121] Hong Jiang Zhang et al., Video Parsing, Retrieval and Browsing: An Integrated and Content-based Solution, in: Mark T. Maybury (Hg.), Intelligent multimedia information retrieval, Cambridge, Mass. / London (MIT) 1997, 139-158 (140)

[122] Zhang et al. 1997: 149

Memory Games? The Warburg paradigm

The computer software called *2gether1 - Das Mosaik Tool* (by the company Games2Play, Hamburg) composes mosaic-like large-scale images based on the mean colour values of a pool of miniature photographies.

Computer-based "visual analytics" attempts at a serious memory game when identifying visual formulas in occidental art history, a kind of visual sub-conscious of collective cultural memory which escapes human iconography. Although Aby Warburg´s *Mnemosyne Atlas* (ca. 1929) looks primarily iconographic at first glance[123], its coupling with new digital image-sorting programs opens up genuinely new perspectives - a productive tension between the traditional image-content based approach and a media-archaeological approach which privileges a genuinely data-based method of ordering images where the reproductions, provided with numbers, can be constantly re-arranged and re-configurated. Just like the famous Warburg file catalogue (*Zettelkästen*) translated both texts and images in alphanumerical notations, the digital matrix allows for "hypermedia" (Ted Nelson) links of visual and verbal information.

When it comes to sorting visual gestures, there has already been a recording medium which Warburg surprisingly did not acknowledge: silent film (until 1928). In early film, there prevailed a sorting of image sequences, by linking of dynamical gestures, while the static textual meta-data (descriptions, dialogues) were interpolated, remaining clearly separated from the visual flow. With sound-equipped film, the supremancy of language entered the space of the images itself - both technically (sound track attached to the single frames) and perceptionally. Even today, many automated search operations (as for news broadcast archives) are rather based on the speech recognition of the clippages (searching for keywords uttered by the anchor-men), not genuinely on visual recognition.

Image archives on the threshold of their digital approachability[124]

The real iconic turn in metadating images is still to come - a visual

[123] Fig.: Vitus H. Weh, Dokumentationstaumel. Ausstellungskataloge und ihre Ordnungssysteme, in: Kunstforum International vol. 155, June/July 2001, 277-282 (279)

[124] Based on W. E., An Image Lexicon of Cinematic Topoi. Film on the Threshold of its Digital Approachability, transl. Andrea Scrima, in: Kunstwerke Berlin (eds.), KW Magazine 01/01 (2002), 10 f.

sorting of images on the threshold of digital image processing and retrieval. While visual and acoustic sources contain types of information and aesthetics a text can never convey, the book or the digital text as a verbal research tool have been much easier to handle comparatively than large amounts of images and sounds; that is why the library is still the dominating metaphor of cultural memory in the West. Since calculating and storage capacities of computers have increased significantly, they can become active agents in digital image archaeology by functions like „searching images“. Instead of having to meta-date images by words, we can handle the data within the image itself; whole audio-visual archives thus become calculable (at least on the level of pixel or scan values). Images and soundtracks can therefore be made accessible in their own medium, if only perfectly adequate algorithms of shape and pattern recognition are being made available.

By statistical operations, qualities can be made evident which have never been seen before in images. All of the sudden, images can be retrieved in their own properties and right - that is, not only by the grace of the accompanying text. After a century of building up audiovisual archives alternatively to textual libraries, the cultural challence now is how to approach these archives in a media-appropriate way - analogous to traditional verbal dictionaries, but organized in a non-alphabetical order (authors, subjects) or even dis-order (ergodically). Mathematician David Mumford has reduced the vocabulary of picture elements (would be pixels?) in Western visual culture down to 23 elements - just like the letters of the (Greek) alphabet.[125] Image-endogenic systems of classification replace meta-dating, such as geometric topologies of image or even cinematographic sequences. Whereas previous image sorting in a primarily writing-based culture has so far been clearly iconologically orientated (Erwin Panofsky), computing now offers the possibility of applying non-semantically operating image-sorting programs which rather recognize shapes, pattern, and schemes, and create a strictly form-based image assortment, as anticipated by Heinrich Wölfflin's *Kunstgeschichtliche Grundbegriffe* in 1915. Art history, seen from the perspective of the algorithmicized machine,[126] conforms with the mathematized, numerical "world picture" Martin Heidegger identified as the central episteme of modernity.[127] Image-based image retrieval operates in harmony with the mediality of electronic images, for in electroniv memory, we don´t have to direct image by meta-data exclusively, but we can open them up immediately according to their genuine optical statements. One digitized, images can be visually

[125] See his *Algebraic Geometry* und his *The red book on varieties and schemes* (1999)

[126] See Ahmed Elgammal, Kreative Computer, in: Spektrum der Wissenschaft 5.19 (2019), 68-72 (72), spektrum.de/artikel/1634766

[127] Martin Heidegger, The Age of the World Picture [lecture 1938], in: idem, The Question Concerning Technology and Other Essays, New York, NY (Garland) 1977, 115-154

calculated and internally navigated.

Elementarizing the Image: Query by Image Content

Images have traditionally resisted all human attempts to describe them exhaustively. Once digitized, images now can be "described" with ultimate precision, addressing and calculating their pixels and colours. In the MPEG-7 format, the image elements are stored along with both technical and semantic metadata. Images are being understood themselves as data sets - a cluster of pixels. Not the images themselves, just their metadata belong to the realm of the archive. Calculating images, MPEG-7 allows for "layered" image composites and discrete 3D computer generated spaces; the shift is from a “low-level” to “high-level” metadata describes the structure of a media composition or even its semantics.

But on the contrary, in order to retrieve digital images by image content, we have to insist on the computability of the imagined world. For monitoring systems to process a large amount of electronic images, such as human faces, such systems have to get rid of semantic notions of *Gestalt*.

This is why the IBM QBIC system (Query By Image Content) does not try to radically decide in the quarel between semantic *versus* non-semantic information, but rather to distribute the task according to the respective strength in the human-machine interface: "Humans are much better than computers at extracting semantic descriptions from pictures. Computers, however, are better than humans at measuring properties and retaining these in long-term memory. On of the guiding principles used by QBIC is to let computers do what they do best – quantifiable measurements – and let humans do what they do best – attaching semantic meaning"[128] - which establishes a feedback-loop between man and machine and stages the difference between analogous and digital data processing, thus not trying to efface, but to creatively enhance the human-computer-difference where they meet on the interface.

Beyond image content?

Visual search engines that can truly deal with iconological queries are still in their infancy - for example *Cobion* in Kassel, crawling the web for illegal trade-mark copying. So far, the similarity-based images retrieval technology is either militarily or commercially, not really culturally driven (as has been frequently emphasized by late Friedrich Kittler).

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[128] Myron Flickner et al., Query by Image and Video Content: The QBIC System, in: Maybury 1997, 7-22 (8)

"Contentism" is the iconological heritage and cultural burden which still semantically hampers truly algorithmic approaches to image collections. "[T]he metadata provided by an image database software I use to organize my digital photos tells me all kinds of technical details such as what aperture my digital camera used to snap this or that image – but nothing about the image content" (Manovich). A techno-mathematical approach to image analysis and synthesis may liberate occidental culture from its inherited contentism.

While computerization made the image acquisition, storage, manipulation, and transmission much more efficient than before, it did not help so far to deal efficiently with the automated description and access to the vast quantities of digital image being generated by digital cameras and scanners, by the endless “digital archives” and “digital libraries” projects around the world, by the sensors and the museums ... - unmanagable by human manpower any more.

From the point of view of speculative realism, technical images themselves have a kind of internal knowledge which can not easily be meta-dated verbally. Searching for the ornaments on a carpet for example, or for the colorit of a tapestry, the user of ICONCLASS would fail, since here he can only find what has been indexed by the cataloguer. In a rivalling picture data bank called IMAGO developed by a software company in Hamburg together with art historians in Berlin at least a „hyperlink module“ allows, by *drag and drop*, to create non-verbal, rather diagrammatic relations between single subjects and text parts - just like Vannevar Bush's 1945 design of a mechanical *Memory Extender*, microfilm-based on „selection by association, rather than by indexing“.

Once a visual flow has been machinically implemented, it can be "automated", resulting (like minimal music) in almost unrecognisable (for humans at least) differential repetitions (phasing). What looks similar to human eyes, is very different by close machine reading indeed.

MEDIA ARCHAEOLOGY AND / OR ART HISTORY. A *liaison dangereuse*

The technical gaze reminds of alternative ways of looking at "works of art". By its close reading, media-archaeological criticism de-narrativizes artefacts of figurative art. Such an analysis of the material and cognitive *arché* suspends the physical object from metaphysical concepts behind like (art) "history" as well. This is not a nostalgic return to traditional antiquarianism; the neo-antiquarian gaze is rather non-human and computational in its "Digital Humanities" sense. The "cold" algorithmic sorting of images results in a different kind of *musée imaginaire*.

Introduction (en Français)

Média archéologie radicale

D'abord une clarification: Il y a des média-archéologies multiples par definition des auteurs divers; comme methode et comme discipline, la média-archéologie est encore *en emergence*. Moi je propose une version radicale de média-archéologie, en sens littéraire de "radical": *radix* en Latin (et *l'arché* en Greque) est le début, l'origin en sense temporel, mais aussi la racine en sens mathematique, le symbole "√". L'archéologie est l'analyse des structures, ne pas des surfaces phenomenales.

La notion du *média archéologie* a un double sense: "l'archéologie *des* médias technologiques", mais aussi l'archéologie *par* les médias, le point de vue techno-mathematique. Le regard et l'opération média-archéologique est d'abord une de-culturalisation, un act de "re-presencing" (Vivian Sobchack), et une de-historization des oeuvres de l'art.

Je ne vais pas discuter les effets indirectes des nouvelles technologies (comme la photographie ou le film) sur les oeuvres de l'art traditionelle comme la peinture et la sculpture depuis le 19ème siècle; cette influence est déjà bien integré dans les recherches historiques de l'art moderne.

Aussi je ne vais pas thématisier *media art* ou l'effet technologique sur l'esthetique est evident.

Il n'y a *pas* une rélation directe entre les études des oeuvres de l'art classiques et l'archéologie des média en sens de technologies. La média-archéologie *respecte* les euvres de l'art (la peintiure, la sculpture) comme un *autre*

- même, dans un sens surprisant, la naissance de la théorie des média était directement inspirée par le Critique de l'Art. Le théoreme central de *Understanding Media*, la publication fondatrice des études médias par Marshal McLuhan (1964) est que "Le médium est le message"; explicitement cette notion était inspirée par la characterisation de Clement Greenberg de la peinture moderniste. Média-archéologie aussi attend pour le "méssage" inscribé dans l'oeuvre de l'art, au-dehors l'individuation subjective et intentionel, mais plutôt en sens iconologique propre: des relations numérique (géometrie algebraique en sens de René Descartes).

Les liaisons entre la média-archéologie et le champ artistique sonst plus subtile - même "dangereuses" au niveau epistémologique. Cette provocation concerne le concept d'une *histoire* de l'art. A ce point je veux souligner que je ne suis pas un critique de l' histoire de l'art comme discipline academique, au contraire: Il y a une necessité pour une

historiographie de l'art en sens de la contextualisation des ouevres esthétiques sur la base des archives documentaires.

Du point de vue historiciste, si l'histoire existe, il faut historisier le discours historique. Pour ca if faut prendre un point distante (critique): (media-)archépologique.

La relation entre média-archéologie et l'histoire de l'art est une "liaison dangereuse" parce-que "l'histoire" est mis-en-question par l'approximation media-archéologique des ouevres de l'art du passe, en faveur de decouvrier par des actes "archéologiques" des autres sedimentations du temps en pluriel ("Zeitschichten" en sense de l'historien Reinhart Koselleck).

L'exercise archéologique est le regard non-historiciste sur les objects; plutôt: le regard *temporalisante*, pour laisser s'articuler le temps-propre ("idéosyncratique") des oeuvres.

La média archéologie plutôt prend une point de vue *complementaire* (ou même alternative) à l'histoire des articulations esthétiques; le regard média-archéologique sur les ouvres de l'art du passé est radicalement non-historisante.

Attendons les peinture derivée de la passé. Le regard non-semantique sur les images artistiques: est-il possible? Pour la première fois, tels objets des musées de l'art peuvent être "interpretée" comme *imaging* par des machines, au-delà du regard anthropocentrique.

Dans la definition du "techno-imaginaire"[129] par le philosophe des médias Vilém Flusser, avec la numératisation des images, ils devient encore des "textes", et leur historicité est effacé. Aussi pour Jean Baudrillard, pour la photographie digitale, il n'y a pas du sense encore de parler de "photographie".[130]

Sélon Flusser, techno-images (" Technobilder ") sont basées sur des textures alphanumériques, ils sont post-historiques ("post-historisch"), au-delà du régime scripurel / historio-graphique.[131]

Pour un moment (*epoché*), il est attractive de suspender l'analyse des euvres de l'art de la hermeneutique des sciences humaines, en faveur d'une scientification - mais afin que dans un deuxième sense ces evidences positivistes sont reliès à l'analyse epistémologique.

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[129] See Vilém Flusser, Into the Universe of Technical images [1985], Minneapolis (Univ. of Minnesota Press) 2011

[130] Jean Baudrillard, Pourqoui tout n'a-t-il pas déjà disparu?, Paris (Les Éditions de l'Herne) 2007

[131] Flusser Archives, University of the Arts, Berlin, typescript "Von der Zeile ins Bild (zurueck)", 3

Car les methodes métriques de l'investigation des oeuvres de l'art ne sonst simplement des technologies auxiliaire pour l'analyse. Dechiffré avec le point de vu média-archéologique, ces opérations sont des évenements et moments epistémologiques au même temps. Ils decouvrent le *momentum* de ce qui passe quand l'homme-auteur (l'artiste) est couplé avec la physique et le logique des matérialités appliques.

Média-archéologie pose la question: Comment les opérations calculatrice sur l'image (*image processing*) affectent la notion de l'histoire de l'art au niveau epistemologique?

[Les computations des oeuvres de l'art par les methodes des "digital humanities" sont statistiques et basées sur une epistémologie algorithmique. Est-que c'est encore humanisme numérique ("computational humanism", Roberto Busa)? En différence aux "Digital Humanities", la média-archéologie des objets d'art passé regard la materialité aussi; ce n'est pas reductrice aux opérations calculatrice. Il y a une relation *inductive* (expression electrique) entre la qualité esthétique et la qualité materielle (téchnique) d'object de l'art.]

Radical Media Archaeology and its complicated relation to the study of art history

Media Archaeology at first sight relates to technological media. Its task in relation to so-called contemporary "media arts" is to de-metaphorize its aesthetic gesture, separating truly technologically induced aesthetics from superficial effects.

But the more difficult question is this: Is there a relation between the study of works of art and Media Archaeology for times *before* technical media in the proper sense? Media archaeology is not simply an additional method to the familiar art historical analysis by describing, for example, the impact of technologies like photography on painting, and by revealing its implicit technical impact on the aesthetic message.

So-called "art history" sprang from a certain discursive necessity in the past. "Historic" research means con*text*-intensive analysis, and the linear ordering of events - mostly achieved by historiographic narrative - since the end of 18th century served to reduce the experience of growing temporal complexity since the French and Industrial revolution (Reinhart Koselleck, Niklas Luhmann). But complexity nowadays can be coped with by mathematical modelling, by computational counting with probabilities in nonlinear ways.

There is "soft" media archaeology which takes care of "dead media" (Bruce Sterling) neglected in the history of culture and technology, which remembers "imaginary media" (Siegfried Zielinski) or which identifies patterns of technological recurrence ("topoi") *within* history of modernity (Erkki Huhtamo). Against the archaeological "digging" and "rediscovery" metaphor, radical media archaeology ("radical" in terms of the mathematical square root) identifies a non-historicist cut by technologies into so-called cultural history. Radical media archaeology has a sense of tempor(e)alities, but no sense of (art) "history".

Radical media archaeology - in its technically "grounded" version - takes its departure from technology in its proper sense. It concentrates on the epistemological insights which can be derived from the close analysis of electro-mechanical media, electronic media, and finally computative machines.

In defence of antiquarianism: Between media archaelogy and history of art

What media archaeography shares with art history is *ekphrasis*, the analytic description of the essential details in cultural artefacts - be it a work of figurative art or a technological devices, both in terms of spatial co-existence of elements (as described in Lessing's *Laokoon* 1766), and in terms of their operative *being medium*. But in this affiity, the difference becomes apparent as well: digital aesthetics of counting by numbers rather than narrative. De-historicizing art history means de-coupling art remaining from the past from its narrative enframing, in favour of a rather diagrammatic, nonlinear time graph to discover different tempor(e)alities of works of art from the past. To the media-archaeological analysis, a "historic" piece of art is always radically present, both in its material and its techno-archival presence. Such an *antiquarian* attitude does not approximate a material artefact from the past to some discourse beyond it but treats it in its own, intrinsic terms.[132] The media-"antiquarian" (like the proper *archaeological*) method can be positively defined as both materiality and data-orientated - both in ascetic resistance to premature "historic" narrativization.

In the materialist emancipation of the object from being subjected to textual analysis alone, antiquarianism ackowledges the hardware from the past independent from historical discourse which provides the software operating upon such materialities. In a digital culture of apparent virtual realities the reminder of the resistance of material world is undispensable.

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[132] Stephen Bann, Clio in part: on antiquarianism and the historical fragment, in: Perspecta. The Yale Architectural Journal 23 (1987), New York (Rizzoli), 24-27 (27)

Physical and computational analysis vs. hermeneutics of art derived from the past

The analysis of the physical, material properties of a painting has been considered useless for the understanding of the meaning in art historical research (Panofsky[133]); this is what is aptly desscribed as "low level" properties in digital image processing as well: the internatl representation of images such as texture, shapes, hue, color distribution. So far this has been interesting for engineers only - which describes exactly the borderline between media-archaeological image analysis and iconological interpretation (visual hermeneutics). Once culture is not reduced to semantic meaning, algorithms which have been developed to analyze digitized works of art can reveal a different kind of aesthetics.

As expressed by Henry Fox Talbot in 1844, the photographic instrument is a true media archaeologist because it is suspended from the cultural semantics of art historical value. It "chronicles whatever it sees, and certainly would delineate a chimney-pot or a chimney-sweeper with the same impartiality as it would the Apollo of Belvedere."[134] In his publication *The Pencil of Nature* (referring to plate III „Articles of China“), Talbot already had pointed out the non-human *archival* efficiency of the photographic shot, its automatic register: "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. The more strange and fantastic the forms of his old teapots, the more advantage in having their pictures given instead of their descriptions."[135]

Wölfflin's formal language: Suspending "past" art from historical discourse

When inaugurating media analysis not only as sociological practice but as true theoretical discourse, Marshall McLuhan was not only familiar with *Art and Illusion* by Ernst Gombrich (Princeton 1960). McLuhan's media theory was even more direclty and explicitely inspired by cubism as an artistic practice in early 20th century which deconstructed the perspective 3-D illusion of flat paintings in favor of revealing its symbolical construction.

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[133] See Erwin Panofsky, Meaning of the Visual Arts, Chicago, Il. (University of Chicago Press) 1955, 14

[134] Talbot 1844: subcription to plate II „View of the Boulevards at Paris“

[135] In: Wolfgang Kemp (ed.), Theorie der Fotografie: eine Anthologie, vol. 1, Munich (Schirmer / Mosel) 1980, 60-63 (61)

Inspired by artistic practice in modernism, media-theoretical analysis focuses on the message of the medium itself. Applied to memory agencies and especially the ‚digital archive', this method demands not only a close analysis of its different technology but a new interpretation of its different epistemological and aesthetical dimension as well. While the traditional archival format (spatial order, classification) will in many ways necessarily persist, the new archive is radically temporalized, ephemeral, multisensual, corresponding with a dynamic user culture which is less concerned with records for eternity but with order by fluctuation. New kinds of search engines will not only answer the needs of media arts but develop into a new 'art of the archive' itself. Already Heinrich Wölfflin in his *Kunstgeschichtliche Grundbegriffe* in 1915 proposed a comparative analysis of basic forms in works of art instead of focusing on their iconological content, such as: linear vs. picturesque, or closed vs. open form. Wölfflin recontructed the set of forms which were available for arists in his epoque - *l'archive* in Foucault's sense.[136]

Information theory has offered a non-cultural explanation of aesthetic value. But can it be called "art" at all when not considered in terms of cultural meaning? The media-archaeological operation here distances art from history (for a moment) with the help of optical and image-processing technologies.

The media-archaeological procedure is dialectic. It suspends art of the past from its historiographical enframing, and then re-discuss it in terms of the elaborate *sciences* humaines (which is *both* philosophical techno-epistemology *and* computational science).

Media archaeology is not concerned with the *historical* past but with present re-enactions. Its analytic target is not simply the impact of technologies on human culture (individually and collectively), but it radically derives insight and knowledge from the instrinsic properties of the technical and/or logical artefact directly.

Computational archaeology of art historical works

The first *technical* revolution of art history as academic practice (if not even its condition) has been the photographic reproduction of works of art (kept in Photothèques); the second is its transformation by computational science ("Informatik").[137]

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[136] Heinrich Wölfflin, Kunstgeschichtliche Grundbegriffe. Das Problem der Stilentwicklung in der Neueren Kunst [*1915], Basel (18. Aufl.) 1991, 5

[137] See the preface by Oskar Bätschmann, in: Guerino Mazzola / D. Krömker / G. R. Hofmann, Rasterbild - Bildratster. Anwendung der Graphischen Datenverarbeitung zur geometrischen Analyse eines Meisterwerks der Renaissance, Raffaels „Schule von Athen", Berlin u. a. (Springer) 1987, IX-XII (IX)

Research into technologies as generative agencies of aesthetic forms (like the impact of the camera obscura, of photography, film, video and the computer on painting) belongs to the field of media history (since it reconstructs historical interrelations between the technological *dispositif* and culture), while the *mathematization* of the image in the Renaissance belongs to active media archaeology since it allows for a non-historicist analysis of such images, *culculating* its geometrical dimensions (as has been pioneered in the "Piero Project" for virtual navigation through the painting).

Recently, scholars like Horst Bredekamp have started to actively include the "technical image" into art historical studies, such as Leonardo's engineering drawings and scientific diagrams.[138] Guerino Mazzola has been inspired by Raffael's painting *School of Athens* not as a *connoisseur* of art but explicitely as mathematician ("als Mathematiker"). Listening to a lecture by the art historian Oskar Bätschmann on the hidden symmetries in this work of art made Mazzola envision to reveal such hidden spatial relations in a Renaissance painting applying methods of modern computational modelling, virtually tracing variances in the perspectival construction.[139] This is truly media-archaeological dis-covery of art-"historical" *implicit* knowledge in both senses: a) the methodological approach (Mazzola) and b) its non-human operation (*active* media archaeology by the computer).

On the other hand, this means: the digital image is always already an archival one; pixelwise it exists in virtual, that is: calculabe space only in an archival mode, like the score in music. With this transsubstantiation the art work is subject to techno-mathematical control - in the micropolitical and the epistemological sense. This makes all the difference between the painterly stroke or even *pointilisme* and bit-mapped graphics.

To search the images themselves in a transitive way is the option provided by the video compression codec MPEG-7 which "promises the ability to tag the image itself. But all these are still text-based. 'We have to write out a description for, or appended to, the image and then search for it by entering the keyword."[140] Color, composition and other image features can be directly tagged to the image - even if this is still metadata, an index, automatically or human-based. But this *textualization* of the image allows for its non-linear diagrammatic ordering. This allows - not only in film studies - for similarity-based search

[138] See the entries "Medientheorie: Bilder als Techniken" and "Kunstgeschichte" in: Bild. Ein interdisziplinäres Handbuch, ed. Stephan Günzel / Dieter Mersch, xxx

[139] Preface Guerino Mazzola, in: same author et al. 1987: XIII

[140] Robert Kolker, Digital Media and the Analysis of film, in: Schreibman et al. (eds.) 2004: 383-396 (395)

for images "by example", especially in big image banks like André Malraux' *musée imaginaire* - reversed, "analytic" kinematographics. Techno-mathematical intelligence is "hardware and software that turned the moving image into binary code, and once so encoded, almost anything could be done with it"[141]. After Kasimir Malewitsch's *Black Square* had defined the ideal grey value of painting, Wassily Kandinsky in 1912 pointed it out: "The final abstract expression of every art is a number."[142]

In the mathematical epistemology of media archaeology, there are almost timeless structures of aesthetics at work which defy the evolutionary concept of art history. There have been numerous attempts to characterize artistic creation as a set of rules such as the Pythagorean Golden Section; in the Renaissance, artists like Alberti and Dürer formalized rules for projective geometry. "Until recently, rules of this type could be expressed only in the form of narrative writing in the native tongue of the author. With the advent of the computer, it became possible to characterize these rules formally to a computer. [...] Noll's simulation of paintings by Mondrian is one of the arliest examples of describing an artistic style as an algorithm."[143]

Optical configurations have existed as *images* sor far only when being in communication with the human beholder who privides the iconological sense. But what happens when an art historical image is not seen by a human but by a machine? Before the massively recursive algorithms of "Deep Learning", it required a human intervention to teach art historical value to computational images; therefore a guiding principle used in image processing is "to let the user do what the system cannot achieve by itself (e.g. the characterisation of a semantic concept)"[144].

Visual analytics: Warburg vs. Manovich

With so-called digital culture, the alphabetic memory returns again - but this time from within the alphanumeric code which is invisible to most human users of such technologies. All of the sudden, on a few Compact Discs, the whole collection of an art museum could be addressed. Such digital sampling transforms the cultural and ethic essence of such a memory, and which are the mnemo-*generative* capacities of recorded

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[141] Kolker 2004: 388

[142] Quoted here after: Raymond Guido Lauzzana / Lynn Pocock-Williams, A Rule System for Analysis in the Visual Arts, in: Leonardo 21, No. 4 (1988), 445-452 (445)

[143] Lauzzana / Pocock-Williams 1988: 445

[144] S. Marchand-Maillet / N. Lasri / H. Müller / W. Müller / T. Pun, The Reality of Automated Content-Based Image Retrieval Systems, in: W. E. / Stefan Heidenreich / Ute Holl (eds.), Suchbilder. Visuelle Kultur zwischen Algorithmen und Archiven, Berlin (Kulturverlag Kadmos) 2003, xxx

data? By analog-to-digital conversion, the representations of art historical works can be stored on digital media not only for archival preservation or televisual broadcasting but in addition for *processing*; this allows the coupling of such cultual-aesthetic memory to mathematical intelligence.

Art historical *ekphrasis* has so far been logocentristic. But there is a computational alternative to adressing images by words which is creating content-based descriptions from a digital image file itself, by algorithmic recognition and descripton of color, texture, shape, spatial location, regions of interest, facial characteristics, and specifically for motion materials, key frames and scene change detection. "One goal of content-based work is to provide algorithms that can automatically recognize the important features contained in an image without human intervention in the process."[145] This does not impoverish but enrich the world of artistic research and brings us to the research tools of so-called Digital Humanities, its limits and transgressions when compared with traditional studies of images.

A non-historical approach to art works from the cultural past by mapping its photographic reproductions has been performed by André Malraux' *musée imaginaire* and Aby Warburg's noteworthy *Mnemosyne Atlas*. Warburg's method of tracing the tentatively "unconscious" cultural memory of visual gestures (derived from antiquity and re-activated in the Italian Renaissance) itself was performed on a technical medium basis, which is: black & white photographies of works of art which could be associatively arranged and re-configured on a black board at Warburg's Kulturwissenschaftliches Institut in Hamburg. Whereas the scholarly print publication of Warburg's *Mnemosyne Atlas* inevitable freezes such dynamic reconfigurations in momentary snapshots, its digital publication at least allows for dynamic access to the single elements of such visual tables and their reconfiguration. Probably the cultural *unconscious* memorizes images like a visual search machines indeed, whereas art history is the academic skill of identifying the iconological and semantic vectors in their thick cultural context. Turing machines in their strict syntax, and symbolical Artificial Intelligence have necessarily missed the cultural semantic ambivalences so far. This is by no means a deficiency to be eliminated by "cognitive" or "neural" computing and machine learning, but rather an alternative to be cultivated to enrich the notion of cultural memory by non-human points of view.

Experiments with the art historical archive: Histogrammatology

Experimental archives differ from the well-organized institutional art historical image repositories. Electronically sampled analog images can

[145] Donna M. Roman, Image and Multimedia Retrieval, online paper Getty Information Institute, xxx

be digitally quantized and thereby transformed into a vast data set, to make them accessible to truly image-based search operations such as matching of similarities, object feature detection, statistical colour value comparision, entropy. Lev Manovich develops this approach in his essay "How to Compare One Million Images?"[146]

In an effort to achieve non-iconologic analysis of images, the *Active Archive* project of the Brussels based artistic research group Constant applied algorithmic processing of digital scans of the huge photographic archive of the Norwegean avantgarde author Ansgar Jorn. "These digital images are made of pixels rich in color informations, but how can one 'order' by color? What is a significant color information? Contrarily to human intuition, for a computer, a white image is an image saturated with red, blue and green. [...] Ordering is then not only following the raw values coming from the digital objects but already transforming them in dialog with a certain understanding of human perception."[147]

Towards a new notion of "art" inherited from the past, the algorithmic analysis of paintings identifies a non-ocular aesthetic essence of images which can only be *arti*culated by computational, that is: informational means.

Looking at images the way a scanner does, results in a new art of the archive indeed: the experimentation with histograms for exploring the digital photo-archive. An image histogram is a media-archaeological, non-iconic way of looking at one and the same photographic picture. This tool is well know from current digital cameras where photographer *a priori* use them as an aid to show the distribution of tones captured. A histogram "acts as a graphical representation of the tonal distribution in a digital image. It plots the number of pixels for each tonal value."[148] By looking at the histogram for a cluster of images a viewer will be able to judge the entire tonal distribution at a glance" - a truly analytic form of *visualizing images*, revealing their immanent, implicit iconicity.

With the current digitalization of most conventional image collections, the temptation is there "[...] to replicate already known models like a database with standard field descriptors and an interface for public consultation mimicking the photo album."[149]

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[146] In: Understanding Digital Humanities, edited by David M. Berry, Basingstoke (Palgrave Macmillan) 2012, 249-278

[147] http://guttormsgaard.activearchives.org, "eleven orderings: guttorm guttormsgaard"

[148] http://sissv.activearchives.org/w/Histograms_in_the_distance, accessed January 5, 2015

[149] http://sissv.activearchives.org/w/Welcome_to_the_Digital_Darkroom, accessed December 11, 2014

But the alternative media-archaeological approach takes the digital scan at its face value. The digitization of an image is not simply a practical conversion from one format to another, "the digitization changes the ontology of the archive itself. […]. The DNA of a digital image is a matrix of pixels that can be manipulated mathematically and allows for a very different set of operations"[150] when compared to the traditional iconological art historical approach.

Informational Aesthetics: Entropy Instead of (Art) History

Media archaeology, when confronted with artistic works from the past, does not historicise them but rather approaches them in terms of computational aesthetics, as developed by Abraham Moles[151] and Max Bense from information theory. Bense in his effort to reach "exact aesthetics" identifed the *aesthetic state* as the "energy" of an artistic object, resulting from the mathematically contrary components order and complexity as previously defined by Birkhoff.[152] According to Birkhoff, the "aesthetic measure" (M) equals the ratio of order (O) / complexity (C), oscillating around the borderline between O and C.[153] The less a work of art is redundant (responding to the already known), the more it is *informative* in the engineering sense as developed by Claude Shannon's in "A mathematical theory of communication" (1948). Therefore "entropy" as a measure in works of art is a category born from information engineering.

The art historian Rudolf Arnheim, in *Entropy and Art. An Essay on Disorder and Order*, once demonstrated what an entropic measure of a baroque painting looks like. For Arnheim, though, this was meant as a critique of the transfer of notions of information theory into the field of art, criticizing that the overall concept of entropy as temporal vector ignores the art historically derived structure of form and suggests that we must (re-)turn our gaze to the "preserved islands of order

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[150] http://sissv.activearchives.org/w/Welcome_to_the_Digital_Darkroom, accessed December 11, 2014

[151] Abraham Moles, Information Theory and Aesthetic perception, Urbana, Ill., 1966

[152] Max Bense, Ästhetik und Programmierung, in: Bilder Digital. Computerkünstler in Deutschland 1986, ed. Alex and Barbara Kempkens, Munich (Barke) 1986, 22-30 (22). See Fig. "Das physikalische Unordnungsschema im Verhältnis zum ästhetischen Ordnungsschema", in: Bense 1986: 29

[153] G. D. Birkhoff, A Mathematical Approach to Aesthetics, in: Scientia,September 1931, 133-146

everywhere"[154] - which chaos theory (Iliya Prigogine) would call *strange attractors*.

As extreme examples "of what he saw as entropy gone mad" (ibid.), Arnheim referred to minimalism, experimental music and avant-garde film - which is exactly where art history ends and contemporary art begins. Truly media-archaeological de-historization results in the intellectualization of art from the past - in the sense of computational *intelligence* (information theory), replacing stylistic interpretation by, e. g., signal-to-noise ratios and entropy values.

Technical image reproduction and entropy: A xerographic *mise-en-abîme* of art historical paintings

Economical display of paintings according to their formats has not only been a practical concern in Baroque collections of painting but has become the subject of paintings itself, in gallery images as literal *imaginary museums* as painted by Panini, Téniers, or Frans Francken II. When a photographic reproduction of such a painting is subject to xerographical miniaturization which then in return is being magnified again, it is subject to gradual entropization:

Fig.: "Umzeichnung des Gemäldes 'Der Bildersaal' von Frans Francken II. Ausschnitte aus dem Prozeß einer fünffachen Verkleinerung und anschließender fünffacher Vergrößerung. Konzept: Ulrich Giersch"[155]

Entropy thereby becomes the "aesthetic measure" (Max Bense) of a display of such items. The *informational* value is what media archaeology detects in image representations, decisively different from cultural or art historical analysis.

Whereas the machine has no criterium at what point a picture is not a picture any more but a shere random distribution of grey or color versions (the media-archaeological perspective), only to humans there is a threshold of figurative sens. Emmett William has experimented with the cognitive borderline between what can still be perceived as a meaningful image and an informal electro-static xerographical distortion; the American artist Ian Burn 1968 proved that even an empty page, re-

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[154] Rudolf Arnheim, Entropy and Art. An Essay on Disorder and Order, Berkeley / Los Angeles / London (Univ. of California Pr.) 1971, as quoted in: Susan Ballard, Entropy and Digital Installation, in: Fibreculture Journal 7 (2005); http://journal.fibreculture.org/issue7/issue7_ballard.html, accessed November 2007

[155] From: Ulrich Giersch, Zettels Traum. Fotokopie und vervielfältigte Kultur, in: Harry Pross / Claus-Dieter Rath (eds.), Rituale der Massenkommunikation. Gänge durch den Medienalltag, Berlin 1983, 59 f.

xeroxed a couple of time, generates entropic distribution of graphical traces.

What do such operations add to a contextual knowledge of Frans Francken's *musée imaginaire*? To photo-electric organs which "look" at such museum pieces from outside historical discourse, it allows to focus attention to elementary shape distribution - dehistoricizing art history.

Sorting images according to formats: The old and the new museum wall

Nowadays it is the computer which, by digital sampling, deciphers images as data-sets. When visual content of museums - once it hat been digitized like in Picture Disk editions of art historical works - becomes alpha-numerically addressable, new options of mobilizing the inherent information by intelligent algorithms is possible. In fact the storage of picture content in computer memory and with algorithmic sorting rather adopts the "St. Petersburg hanging" according to spatially distributed economy of formats and image compression rather than according to subjects or as time-ordered unfolding.

Digitally interfacing the museum from within: *Metasyn* and new options of sorting images in space

What happens if the user-friendly virtual interfaces which museums have created for the Internet public re-turns (into) the museum space itself? The Museum of Contemporary Art in Roskilde (Denmark) has experimented with *Metasyn* for example, "an interactive visualization that gives visitors an insight into the collection [...]. The content of the visualization is based on the museum's database and the analogue video and sound sequences that have been digitzed to date. The physical interface constists of a six-meter-wide, slightly concave screen and a handheld pointing device that rests on a cylindrical mount. On the screen, more than 1,000 physical objects from the collection and more than 2,000 digitized sequences originating from those objects are represented as icons in three-dimensional space. Using the pointing device, visitors can look around and nagivate quickly through the collection."[156]

"At the Macro level, the entire collection is presented in a diagram where a single selected object is put into the context of the whole. A horizontal timeline, spanning approximately a century, divides the digitized sequences in the upper hal from the physical objects in the lower" <91>.

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[156] Carl Emil Carlsen, Metasyn, in: Re.Action. The Digital Archive Experience, hg. v. Morten Sondergaard, Aalborg (Aalborg UP) 2009, 89-97 (89)

"It's possible to fly back or forth in time to hear and see how the ideas, styles, and use of technologies gradually change in the art works. [...] the naviation clearly reveals time-based delvelopment in the museum's various and changing areas of interest" <93>.

Art history and the (new) museum

The chronological hanging of pictures and placing of monuments in cultural museums, such as past 1800 in the Alten Museum in Berlin, has been philosophically anticipated in the final passages of Hegel's *Phenomenology of Mind*.[157] This order is being de-constructed by the recombinant computing power of the virtual, that is: algorithm-based museum, resulting in a kind of dynamic, never-final archive: "Digital archiving could break up the alliance that the museum has maintainted with history or even historicism since 1800. The chronological sequence, as the emptiest of all kinds or order in which stored things are to be put, could be replaced by an order of co-presence once their combinatory connections were located."[158] Digital archives provide the museum with "combinatory power"[159].

The Media Lab at the Rijksmuseum Amsterdam has developed the Web Portal *Rijksstudio* to become one's own virtual curator[160]; and the Tate Britain in London has initiated the *Tate Collective*, a room in the center of the gallery as experimental space for virtual sorting of images, experimenting with other forms of picture display on the museum walls. The St. Petersburg hang for example connects closer to the visual experience in current Web 2.0 photo and video microblogging platforms like www.tumblr.com or YouTube.

The Virtual Curator which as software from the Rediffusion Simulation Research Centre at the University of Brighton is an authoring environment which enables the user not just to walk at random but to work within the metaphor of the museum. "The user has access to a museum store of objects that are unclassified. They are able to classify the objects and sort them into groups. [...] The software [...] offers the user an active role."[161]

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[157] Friedrich Kittler, Museums on the Digital Frontier, in: Thomas Keenan (Hg.), The End(s) of the Museum, Barcelona (Fondació Antoni Tápies) 1996, 67-80 (68)

[158] Kittler 1996: 75

[159] Kittler 1996: 74

[160] https://www.rijksmuseum.nl/en/rijksstudio

[161] See Colin Beardon and Suzette Worden, The Virtual Curator: multimedia technologies and the roles of museums; paper published in: E. Barrett & M.Redmond (eds.) Culture, Technology, Interpretation: the Challenge of Multimedia, MIT Press, Camb, Mass. 1995

Andy Warhol once proclaimed: The best museum is a department store.[162] What is known in economy as "chaotic shelfing" for storing objects in magazins, corresponds with dynamic storage in Random Access Memories within computers. So let us media-archaeologically cultivate the informative dis-ordering of art history.

ON NATURE AND THE UN-NATURAL. Re-visiting the *Wunderkammer* with media-archaeological eyes

A critical approach to the "return" of the Wunderkammer

In the visual aesthetics of user-generated Internet communication (so-called social media), the almost anarchival disorder of the Baroque curiosity cabinet (*Wunderkammer*) with its unique combination of works of art, technology, and natural artefacts, seems to return. This is not simply a superficial nostalgia for a non-classificatory, rather similarity-based "order of things" as practiced in Renaissance and Barocke times (Foucault), but this recursion indicates a deep-structural affinity between the Wunderkammer and the dynamics of the Internet. This might be positively interpreted as a symptom of a new techno-museological aesthetics: the "algo-rhythmicized" Wunderkammer. But first of all it takes a critical approach to the apparent "return" of the Wunderkammer in Internet times. How such a formation which had been completely displaced can turn up again massively? Traditional evolutionary models of cultural history fail here and ask for new figures of *iterative time*.

While the idea of the Wunderkammer had been forgotten in museological enlightenment (literally), to the generation of social media users it becomes interesting again. The miscellania that the curiosity cabinets used to display in the Renaissance and Baroque period, as well as the way these heterogeneous items were displayed, seems not unlike the manner in which digital archives and the Web are being organized - or dis-organized - today (Heloisa Amaral).

So what is the present nostalgia for the Wunderkammer a symptom for? It is the fascination of the Wunderkammer with "artificial nature" such as automata? In the curiosity cabinet, there was no ontological dichotomy between technique and "nature". The same is true again for digital culture when nature itself becomes virtual physics like in computer games: a simulacrum or even emulation. Only with the conceptualization of art *history* since late 18th century, works of art have been separated from machines as technical masterpieces in favor of aesthetics.[163]

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[162] As quoted beforehand in the thematic issue "Leegte / Emptiness", in: Mediamatic 3#4 (Juli 1989), 195

[163] See Bredekamp 1993: 33, and 88

The apparent disorder of the Wunderkammer in Baroque times was perceived as a hidden order of creation whose secret ratio was known to God the creator exclusively. The "digital Wunderkammer", on the contrary, exists without such theological background; image clusters are organized by algorithms which are known to the human programmer and have been "embodied" (computatinally implemented) in machine operations. Thereby, the creative potential of the new Wunderkammer in the Internet era carries within also a risk: "the danger of 'endless freedom', of never having to formalize knowledge"[164].

The museological fascination regarding the Baroque Wunderkammer today is two-fold: there is the anti-taxonomy of similarity-based order; and then there is its remarkable respect for the un-natural in nature and the artificial in terms of technology.

In the Wunderkammer, *naturalia*, *artefacta* as products of human culture, and *scientifica* (devices of human mastering of nature, such as astrolabes, clocks, automata, and scientific instruments"[165]) met in incompatible ways: "Resemblance was central to the baroque delight in paradox."[166] But such union of "incompatible distances" (as once expressed by Thomas Browne) nowadays is calculated mathematically. "To think in the presence of a cryptic *Wunderkammer* [...] required a calculus of combinations for inferring the connections among thousands of unknown aspects"[167], like the algebraic generation of new concepts in Leibniz's epitemology. It is this mathematically sublime aesthetics which Gilles Deleuze re-discovered in Leibniz in his book *The Fold*.

How to cope with strange natural forms like the Nautilus shape? The relation between the ancient Wunderkammer and infinitesimal mathematics and logarithmic analysis is deeper than it is apparent at first glance. In contemporary compositions like Johann Sebastian Bach's fugues, the "general bass" base represents a musical equivalent such a calculus indeed. Leibniz is not just a contemporary of the European *Wunderkammer* but its radical transformator. His differential calculus mathematised the wonders of God's creation, replacing the juxtaposition of forms by algebraic formulas.[168]

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[164] E-mail Heloisa Amaral, April 24, 2015

[165] Koeppe, as quoted in: Breen 2012

[166] Barbara Stafford, Visual Analogy. Consciousness as the art of connecting, xxx, 121

[167] Stafford xxx: 122

[168] "Mit dem Kalkül war ein Weg gebahnt, dem 'unendlichen Autor' Gott in seine Physik hinein zu folgen." Friedrich Kittler, Ein Tigertier, das Zeichen setzte. Gottfried Wilhelm Leibniz zum 350. Geburtstag, in: *mtg* (Medien/Theorie/Geschichte), bulletin of the DFG Research Network *Theorie und Geschichte der Medien* (1996); http://www.uni-kassel.de/wz2/mtg/archiv/kittler.html

René Descartes and Gottfried Wilhelm Leibniz once radically broke with the *Wunderkammer* epistmology of similarities and resemblance in natural and cultural objects; they replaced both the *ars memoriae* and the collection of curiosities by calculating with numbers. Referring to common units, only measurement precision enables to analyse like things according to the calculable form of identity and difference.

But even Leibniz' *Dyadik* (celebrated today for its reduction of mathematical calculation to binary numbers) was still presented within the frame of a religious view of God's creations, as expressed by Leibniz as "wondrous creation from Zero and One". The epistemic rupture is dramatic and should not be confused with present nostalgia. The present Internet is a result of algorithms. What looks like a curiosity cabinet on the "content" level is in fact an audio-visual or narrative dissimulation of data strings.

Are similarities between objects and images strictly formalisable, to be revealed by algorithmic pattern recognition? It is the task of the robot scholar to uncover and display this unexpected coherence - a mathematical kind of archaeology of knowledge, based on the assumption that what looks contingent to men, is a hidden coherence in computational eyes. What looks like the digital "recursion" of the Baroque curiosity cabinet in the Internet is based on a fundamental mathematical classification. Nowadays it is the computer which processes images of the *Wunderkammer* as data-sets. Once it has been digitized, visual content of museums becomes alpha-numerically addressable, and wondrous new options of mobilizing the inherent information by intelligent algorithms arise.

Memory games

Software imposes structure on the apparent disarray of phenomenal data sets by searching for matches amongst the otherwise jumbled elements. Montaigne once supposed that similitude binds everything together[169]; with this poetic epistemology, similarity-based algorithms of image organization in the present correspond.

In a Flash animation on the still existing website of the *Searching Image* project from 2001, an array of moving pixels progressively associates with each other by colour similarity.[170] Is the computer capable of more sophisticated forms of visual rhetoric? The strength of computing does not develop by just emulating human image perception.

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[169] Michel de Montaigne, Oeuvres complètes, ed. Albert Thibudet / Maurice Rat, Paris (Gallimard) 1962, 1047

[170] www.suchbilder.de

Digital computing only by massively recursive "machine leaerning" can identify the whole of an object from the sight of a part of it. "The computer is no good at spotting associations between seemingly unrelated pieces of information and deriving generalizations“ of images.[171] Fuzzy computer-sorting might begin to make useful comparisons of similar but not identical images on the basis of new protocols, just like neurons in the human brain do not primarily process, recall and transfer iconological content but rather patterns of visual memory. The image here exists rather in a structural, that is: proto-archival latency.

The hanging of pictures: Order *versus* entropy

By similarity-based algorithms of image organization in the present, computers juxtapose pictire elements according to exact numerical neighbourhood; their patterns are to be read as comparative juxtapositions, "as a system of potential matches"[172]. In fact the storage management of visual content in computer memory rather adopts the old "St. Petersburg hanging" of pictures at the wall according to spatial economy of formats rather than according to subjects or as historical sequence in period rooms. Apparently likewise, the photo-aesthetics of a blogging-platform like Tumblr is literally based on the *tumbling* of images. What articulates itself here, is the appeal of the "anarchive" which is closer to the *matching* of items in the *Wunderkammer* than to the modernist archival tectonics.

The return of the *Wunderkammer*?

It is the code which governs computer graphics; highly structured algorithms define unexpected constellations. In that sense, Friedrich Kittler once predicted the return of the *Wunderkammer*.[173] The ultimate digital Wunderkammer of today does not simply archive snapshots from the Internet but hardware architectures and software solutions as well - to preserve the validity of mathematical algorithms. The apparent return of the Wunderkammer in Web 2 - like the archival metaphor for the Internet - is only superficial; on the infrastructural level, a complete transformation has taken place: from contingent objects to rule-governed calculation.

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[171] Davies et al. 1990: 61

[172] Claire Preston, In the Wilderness of Forms: Ideas and Things in Thomas Browne´s Cabinets of Curiosity, in: Neil Rhodes / Jonathan Sawday (eds.), The Renaissance computer: knowledge technology in the first age of print, London / New York (Routledge) 2000, 170-183 (174 f.)

[173] Kittler 1996, referring to: Horst Bredekamp, Antikensehnsucht und Maschinenglaube. Die Geschichte der Kunstkammer und die Zukunft der Kunstgeschichte, Berlin (Wagenbach) 1993

The material artefact with its physical presence can not easily be emulated by reproduction in virtual space - unless the object is scanned in 3-D and can be calculated in its visual vectors in *n*-dimensional space, analytically becoming even more accessible than any object in physical display.

The "imaginary museum" (as defined by André Malraux) once started with photography[174] and became even more dynamic with Aby Warburg's *Mnemosyne Atlas* which is based on the idea of permanent experimental reordering of photographic reproductions of art works by iconological or orther affinity. The very affordance of the technical reproduction induced such new epistemic operations - to be continued in algorithmic space.

[Internet / Wunderkammer]

In his article "Cabinets of Curiosity: the Web as Wunderkammer", written for *The Appendix* blog[175], Benjamin Breen refers to well known Wunderkammer representations in the Internet, such as Frans Francken's painting of a Kunstkammer, 1636. But "behind" such a digitized image in media-archaeological analysis, it turns out as a RAM image, symbolically represented rather by hexidecimal code then by visual pixels - the mathematical *Wunderkammer*. Is this a weak, even misleading metaphor? Breen takes "the ecosystem of Pinterest" for example, and finds here "the same organic arrangement of contrasting items, grouped poetically (rather than rationally) around a nebulous theme" (Breen), like in a Baroque Wunderkammer. "The eclectic and exotic are prized; color and visual interest win the day." The context for each item is "virtually nonexistant" (Breen ibid.).

Likewise YouTube, Flickr, MySpace for film, photo and sound; Facebook for text. Tumbl as a mix of all was founded in 2005 by David Karp who originally created his blog for thought fragments appropriately called *Anarchaia*; net links and quotes were called "tumblelog". The Tumbl button allows to immediately "appropriate" quotes (and images, sounds) from the Internet into one's own blog as virtual *Wunderkammer*.[176]

There is an obvious temptation or even desire for *de*contextualizing images, for freeing them from their strict placement in the art historical context. Here the fascination with the out-dated Baroque

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[174] André Malraux, Psychologie de l'art - Le musée imaginaire, Geneva 1947

[175] Posted by Benjamin Breen on November 28, 2012; http://theappendix.net/blog/2012/11/cabinets-of-curiosity:-the-web-as-wunderkammer; accessed March 9, 2015

[176] See taz.de (the Berlin daily journal Die Tageszeitung), article from April 9, 2010: "Microblogging mit Tumbls. Das Durcheinandertagebuch", http://www.taz.de/!50880

Wunderkammer comes in, as museological "attention to aesthetic forebears that lie outside the austere traditions of minimalism and modernism. Perhaps the pendulum is swinging back to a Baroque celebration of diversity of forms, asymmetry, eclecticism and a more poetic sensibility that injects a degree of intuition and randomness into the realms of machine intelligence and digital communication", Breen comments. But then, the current appeal of the curiosity cabinet and *Wunderkammer* is not simply nostalgic but rather a retro-effect, a *dèjà vu* of the Internet warehouse aesthetics with its apparent chaotic shelfing: The ways a *Wunderkammer* creates surprising juxtapositions between objects and ideas that usually don't belong together looks familiar to virtual navigation within online worlds. In fact, the labels are here literally *inscribed*: Each image pixel itself is a numerical address, thereby the opposite of the non-mathematical Wunderkammer arrangements.

While there is no centralized directory in the Internet, search engines "provide navigation methods just as labeling of items in a 1500s curiosity cabinet led viewers through the myriad of items it contained [...]."[177] But "unlike the curiosity or wonder cabinet that only accepted items that the owner deemed appropriate, the freedom to add to online content and categorize without oversight from a single governing entity allows for an ever-changing and adapting environment" (ibid.).

Similarity-based Dis/Order in the radicalised Wunderkammer. Human *Lógos* vs. Artificial Neural Net in Legrady's *Pockets Full of Memories*, and Constant's *Active Archives*

The human brain itself operates by association which is explicitly emulated by similarity-based retrieval algorithms. The Kohonen Self-Organizing Map which, in turn, has been applied by George Legrady's media art intallation *Pockets Full of Memories* in the Paris Beaubourg (2000). The linear order of visual motives has been replaced here by minute recognition of differential values, the *Delta* drive.

Computer scientist Teuvo Kohonen divides the memory models into two main categories: *physical-system* models and *information-processing models*[178]- which separates the Baroque *Wunderkammer* from its algorithmic version in the Social Web of today. For Internet culture today, WEBSOM has been developed by the Neural networks Research Centre at Helsinki University of Technology, as a method for automatically

[177] Jessica Ezell, The Internet as Cabinet of Curiosities, in: Information in Social and Cultural Context (Spring 2012), http://blogs.ischool.utexas.edu/inf380c/author/ezell, accessed March 23, 2015

[178] Teuvo Kohonen, Self-Organization and Associative Memory, Berlin / Heidelberg / New York / Tokyo 1984, 4

organizing collections of documents and preparing visual maps of them to facilitate the retrieval of information.

In Legrady's media art installation *Pockets Full of Memories*, visitors were invited to scan personal items, and then to ascribe affective values to then by means of a computer touchscreen with a pre-set questionnaire. The resulting values as database then led to the algorithmic placing of scanned objects on the large two-dimensional map.[179] On this visible surface, the "imaginary museum" does not place incoming objects in a pre-existing spatial order but was in constant motion, driven by the visitor's tags to their individual object contribution which were organized through the self-organizing map algorithm. But this combination of user-generated emotional, semantic content (human *lógos* as a function of tagging verbal metadata), and computational method (the rather associative neural net) still confirms the human agency, instead of being more radically driven by the fully automatic distribution of shapes, textures, colours etc. from the scanned objects themselves.

The real *l'archive* in the strict Foucauldean sense as condition of possibility for enunciative statements like this, though, hides within the order of the Kohonen self-organizing map and stays strictly immobile (not changing a single source code line during the installation). Against the metaphorical visual interface, a different map (as archival diagram) is at work here. What might look like randomness in the dynamic re-placement of visible objects therefore is heavily structured[180] on the archaeological level of media operativity.

A more radical version might order the digitally scanned objects according to formal criteria by truly image-based sorting such as order by shape or by colour distribution. When applied to collections of art historical motives, the evolutionary order is thereby replaced by the differential drive to find similar patterns.

Even if still "tagged" by human semantics, once being sorted by algorithms in a data bank, such image clusters invite to be analyzed in non-human machine aesthetics as such - statistically resulting in color histograms, or in hybrids of color distribution and human labelling.

With effective algorithms, for the first time, the image archive can organise itself not just according to external verbal description, but according to criteria proper to its own data structure: an endogenic visual memory in its own medium. By translating analogous photographic images (including film) into digital codes, not only do images become addressable in mathematical operations, their ordering as well can be

[179] Sven Spieker, On the Question of Archives and Entropy in Contemporary Art (Legrady, Muntadas), in: Krzysztof Pijarski (Hg.), The Archive as Project. The Poetics and Politics of the (photo) Archive, Warschau 2011, 114-126 (116 f.)

[180] Spieker 2011: 117

literally calculated. While the traditional photographic archive still represents a spatial order ("l'espace de l'archive"[181]), today the online image archives themselves take place in time. Dynamic access to image archives is a flexible tool which allows for the coexistence of different orders without destroying the existing database structure.

The *Wunderkammer* is radicalised by media archaeological analysis, when the term "radical" is understood in its mathematical sense: the square root. Very often, what the cluster of features reveals, from automatic feature extraction of objects in large digital image banks, is rather puzzling - not from the computer perspective, but from the human first glance. Such probes have been assembled by the Bruxelles-based research art collective Constant (Active Archives, Nicolas Malevé and Michael Murtaugh). By getting adapted to such techno-mathematical operations, a different ratio is revealed, and expressed techno-logically. When processed through a software machine (the algorithm), records become readable, writable and executable "and therefore the material is provided with the ability to 'speak' for-itself"[182].

While the juxtaposition of the matching features can sometimes be understood by humans intuitively to look alike, in other image clusters, the ratio that connects them seems to evade human visuality and stays hidden in their algorithmic morphology. Nowadays, there are non-human visitors to the digital *Wunderkammer* which, by their probabilistic processing of data objects, apply distant observation which corresponds with the media archaeological gaze.

Image-based image retrieval and sorting algorithms might not try to emulate high-level human perception any longer, or even to hermeneutically "understand" an iconological scene. It might rather be allowed to discover zones that have specific unforseen characteristics, in a productive incommensurability between the algorithmic output and what appeals meaningful to human recognition.

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[181] Michel de Certeau, L´espace de l´archive ou la perversion du temps, in: Traverses. Revue du Centre de Création Industrielle No. 36, January 1986, 4-6

[182] Geoff Cox / Nicolas Malevé / Michael Murtaugh, Archiving the Databody: Human and Nonhuman Agency in the Documents of Erkki Kurenniemi, in: Joasia Krysa / Jussi Parikka (eds.), Writing and Unwriting (Media) Art History. Erkki Kurenniemi in 2048, Cambridge, Mass. (MIT Press) 2015, 125-141 (134)