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"... ELSE LOOP FOREVER". THE UNTIMELINESS OF MEDIA

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In 1936 the "invention" of the computer was a by-product of Turing's answer to the mathematically undecidable: "Computable" numbers are those which are calculabe by *finite procedures*. <Turing 1936/37>. The question if computer programs have a sense of ending (the *Halteproblem*) leads to the more general consideration of media-induced temporality. Not only that media systems internally develop new forms and performations of temporal sequences and a different notion of "ending" (finite algorithms for recursive functions, real-time operations) and provide of a mirco-dramaturgy of temporal proporties, but they are able to externally address the human perception on its most essential channel of being-in-time. Thus Martin Heidegger's philosophy of *Sein und Zeit* has to be extended to (and is being undermined by) questioning media temporality.

Algorithmic time

Let us start this media-theoretical perspective on the question of a "sense of ending" with the very term *medium* itself. By definition, Greek *metaxy* (as defined by Aritotle in his *Physics*, book IV) and its Latin translation *medium* is grammatologically (in logical syllogisms as the "medium term") and technically located inbetween beginning and end, sender and receiver, data input and output, and so forth: as the intermediary, thus temporally ephemeral channel of transmission (as defined by Claude Shannon's *Mathematical Theory of Communication* in 1948), or as the processing unit in computing. Interpreted in this way, the medium/ channel always remembers the input and anticipates the output - with a "sense of ending" temporally directional signal processing (such as the so-called von-Neumann architecture of current computers). A current diagnosis states that the current plurality of media itself has already started to converge into one dominant meta-medium, the interconnected computer, with books and newspapers, film, radio and television finally ending as technically independent media and re-turning in a ghostly shape, as mere formats within the new computational frame (so-called "digital culture"). Is the very term "media" not only an expression of an always already anticipating sense of ending, but itself doomed to end in universal computing <Kittler 1986: Preface>.

Culturally, the most common way of information processing is the human-machine communication (and its time-critical escalations, such as comuter games). The temporal constellation which has replaced the narrative, dramatic aesthetics of (tragial or happy)

ending, for computer games and human-computer interaction in general, is the mode of *interrupt*. Thus, *kairotic* time replaces *chronos*. Such interactive events between computer and human unfold in ideosyncratic time (based on the "interrupt" mode of computing), rather rhythmically than algorithmically, in contrast to the computational steps that unfold within the computer itself, where instruction-execution histories express an ordering of inner events of an algorithm without any relation to the actual passage of time. "Algorithmic time is intentionaly measured by number of instructions executed <...>. Operation sequences are interactive streams with temporal as well as functional properties, while instruction sequences describe inner state-transition semantics" <Wegner 1997: 83f>.

To describe the temporal coupling between human and machine on the one hand, and machine-to-machine communiation on the other, Shintaro Miyazaki has introduced a neologism: "Algorithm", a combination of algorithm and rhythm. Algorithm in computer science means a finite sequence of step-by-step intructions, a procedure for solving a problem, while rhythm is defined since Platon as a time-based order of principally infinite movement <Miyazaki 2009>.

Finite State Machines and the *Halteproblem*

The question if technological artefacts - "non-human agencies" (Bruno Latour) - have an implicit (physical and/or mathematical) sense of temporality immediately leads to the question whether machines are gifted with "consciousness". The philosopher of cybernetical logic, Gotthard Günther, ascribes to machines the possibility of consciousness - though not self-consciousness (a quality reserved for human intelligence) <Günther 1963: 203>. Consciousness is no material quality, but "a metaphysical instance of existence which can smoothly be translated from one existential 'aggregate state' into another" <ibid., translation W. E.>. This almost literally rephrases Turing's notion of the machinic "states". Can machines be *conscious* of their temporal state? According to Turing, the computing machinery is at any discrete temporal moment "conscious" of its state as being read from symbols inscribed on the intermediary recording tape. Thus man can invest the "countable", thus "clocking" parts of his own consciousness into the machine.

"The theory of automata deals with machines which are intended for production of sequences of machine states. <...> the *finite-state machine*, is an abstract system which has a finite set of internal states" <Kohonen 1995: 16>. A mathematical calculation thus is a change of the memory state of the machine. Starting from an initial state, passing a pre-programmed sequence of intermediary states a final state is being achieved. Undisputable precondition is the algorithmic structure of the procedure, i. e. with a finite series of steps a finale state must be achieved.

Do computers, in order to be functionally usable, have a sense of ending? For computing in the sense which got dominant in current media culture this question is not an epitemological luxury, but essential. The computer as we understand it (the Turing Machine) was invented by Alan Mathison Turing 1936/37 as an answer to the mathematical *Entscheidungsproblem*. Crudely formulated, the question of ending startet the age of digital media. Turing's machine reasoning was triggered by the *Entscheidungsproblem*. In mathematics, the *Entscheidungsproblem* (German for "decision problem") is a challenge formulated by David Hilbert in 1928: the search for a general procedure which allows within a formal system to decide if a problem can be solved withend limited time or not. Turing's theorem prooved the impossibility of such a prediction, by transforming the original mathematical-logical question into a temporally determined one: the *Entscheidungsproblem* becomes the *Halteproblem* and thereby a time-critical question ("critical" here in the sense of a necessary decision). Can a Turing Machine decide if another one can solve a problem within limited, ending (German: *endlich*) time? The sense of ending here is transfigured into a new from of dealing with infinity, as cultivated by transfinite mathematics (Cantor). The Turing Machine (which is mechanized mathematics) is to be understood from the dynamic perspective of temporal processuality. These temporal processes take place in the realm of real numbers, of which the computable numbers are a partial quantity (that is, in machinical managable way, the calculable part). "The writing head of a Turing machine inscribes symbols one by one in an infinite string, giving rise to time as a sequence-stream" <Varela 1999: 268>. The strict sequentiality of the Turing machine and its operational table embodies an element of intuitional mathematics contrary to Hilbert's self-referential play of symbols: the hypothesis of a temporally structured, sequentiality, as known from human consciousness.

Finite-state machines operate as linear sequences of events in time <Minsky xxx: 12>. These events happen as discrete moments with nothing happening inbetween (the "time of non-reality", as once casually named by Norbert Wiener). This temporal rhythm might be compared to the ticking of a clock - numerical variables for time *t*. The *Halteproblem* (among other *Entscheidungsprobleme*), to repeat its essential feature, searches for an algorithm to decide, if programs, automata or computer will stop in case of certain or all inputs or not. The stop problem wants to decide whether a logical machine can stop solving a problem after a finite number of steps. For Turing machines such an algorithm is possible for single machines, but not for all in general. There is no automatic procedure which can decide for any program, if it contains an endless loop or not <ibid.>. For example, written in pseudocode, the program "while True: continue" does not halt; rather, it goes on forever in an infinite loop. On the other hand, the program "print 'Hello World!'" halts quickly. A straightforward way to compute looks like this: "if f(i,i) == 0 then / return 0 / else loop forever" <Wikipedia>. The question is whether the given

program will ever halt on a particular input. Almost paradoxically in the context of "the sense of ending", the question of ending in the Turing Machine as *finite automaton* is based on the (purely theoretical) assumption of an infinitive, endless storage tape for intermediary notation. The configuration of a loop, the iterative principle, and recursive procedures are the predominant *chrono-tropes* in computing time. But the loop structure has been already characteristic of the classic magnetic tape (reel-to-reel). Let us repeat: "loop forever"; this reminds of Samuel Beckett's play *Krapp's Last Tape* (first performed in London 1958) which ends with the director's note "tape runs on in silence" - an endlessness which has been answered by technology by introducing the auto-stop mechanism at the end of a tape. There is a growing asymmetrie between media time (the tapes which re-play Krapp's voice invariant to temporal progression, whenever it is subjected to the magnetic recorder), and Krapp's biological existence which is subject to aging (that is: entropy).

Any enjoyment of a musical performance which is done by real humans in real time and space (be it oral poetry as sung by Homer, be it a muscial concert) is always already accompanied by melancholic knowledge (that is: the irony) of its ending. On the contrary, audiovisual machinic recordings (the gramophone disc, the video tape) can be replayed with no internal sense of ending. To modify Walter Benjamin's analysis on "The Work of Art in the Age of Technological Reproducibility", with technical re-petition the temporal aura (which is based on the allegorical awareness of ending) is lost.

Already with photography, the unique moment becomes reproducable (Roland Barthes) - extended to life-as-movement by kinematography. While the traditional archive of predominantly textual records provides a spatial order ("l'espace de l'archive", as described f. e. by the historian Michel de Certeau), to be transformed into "history" by the very act of writing, the audio-visual archives themselves take place in time.

"Zeit" in German is a noun, suggesting substantiality; in English, though, there is as well the verb *to time*, *timing*" - and only Heidegger dared to make use of the word "zeitigen". The same structure happens for "end" ("Ende"), leading to *ending* - a temporalization of "time" and "end" themselves.

Being-to-death (Heidegger)

Marshall McLuhan named it in 1964, in his classic *Understanding Media*: The message of a technological medium is the change it induces with the frame of reference, the speed and schemes of the human situation. Audio-visual media address us at the essence of our sensation of being which is the temporal sense. They re-generate temporal experience, thus adressing the human on the

sensory (aisthetical, physiological) level as radically present, while our cognition puts it into a "historical" context: here, a dissonance takes place, a gap opens, a *différent* in Jean-François Lyotard's sense (referring back to Kant).

According to Heidegger, it is the knowledge of death which inscribes a temporal vector into the human sense of being, so-called existentials ("Existenziale"). This cognitive horizon anticipates death always already <Heidegger 1927 / 1979: 234>. Humans live with the implicit awareness that their death is already future in the past, a dynamically deferred *futurum exactum*. This pattern escalates dramatically within electronic media, turning Heidegger's question from an ontological one into an analysis of micro-temporalities which take place there, critically. Heidegger's ontological archaeology of temporality within human being is decisively anthropocentric, explicitely opposed to reified time as embodied in a trivial machine: the mechanical clock. But with the cultural mastering of electro-magnetism (electronics and computers) a form of processing temporal moments came into the world which unfolds a temporal *kosmos* of its own, its very own chronosphere which needs (analogous to Heidegger's analysis) a *media archaeology*, practicing not "ableitende Begründung", but "aufweisende Grund-Freilegung" <Heidegger 1926/1979: 8>, uncovering the eventuality, which is: temporality (and finiteness) of being <ibid., 375>. Let us perform this time-critically, that is: on the micro-temporal level of electrophysical media.

To translate the Heideggerian analysis of being-as-time to computing: A Turing Machine - that is, a class of mathematical concepts rather than a physical object - is not yet a computer in its full sense. Only the interrelation of logics and matter, of formal sytems and their physical implementation, allow to speak of a computer in its full real sense, becoming powerful as implemented mathematics. Turing, while exploring the limits of mechanization of mathematics, defined mechanism as symbol-manipulating device, abstracted from physical properties. Indeed such a Turing machine , by varying what it reads as its input, can be made to behave like any possible symbol manipulation machine (but only such a machine, different von machines "calculating" with physical entities themselves, such as the analog computer computes with electricity itself). But in order to compute, a symbolical machine has always to be implemented in the physical world as hardware - be it as operations with a pencil on paper, or be it in electronic circuits. Once a computing mechanism is in the (physical) world, it is subjected to temporalities. This is the "subsymbolical level" (Martin Donner) of physically implemented logics (mathematics). Media-ontological analysis reveals no static being, but the essential processuality of media-time (their operativity) - somewhat close to Charles Sanders Peirce's triadic semiotics, with its accent on *infinite semiosis* (thus taking place in temporal dynamics). A Universal Turing machine can emulate every conceivable symbol processing machanism without changing its

basic structure. Emulation refers to the logical modelling of one computer (a previous one - downward-compatible) by another; in this sense the universal TM is an emulation of another TM. Simulation, though, refers to the modelling of the concrete temporal modelling of the behavious of the reference computer under question as well.

The being of technical media is incompatible with a motionless ontology.

Computing (with) time

In mathematics, Newton and Leibniz have developed a might tool known now as differential and integral calculation in order to cope - for the first time in occidental intellectual history - with temporal objects, notably speed and acceleration, as opposed to discrete mathematics which has combinatorial subjects (like the digital computer). "Analogue" computing has such a sense of (physical) time, different from numerical computing. Numerical mathematics constructs discrete algorithms to cope with continual mathematical problems, in two models: direct computing which after a finite temporal process delivers the exact solutio, and approximation. Numerical procedure replace a continuous mathematical problem by a discretes, that is: finite problem, at the cost of errors which results from the very act of quantization (such as sampling). There is a kind of "digital computing" *avant la lettre* which lacks a sense of ending because of its very repetitive measuring of time itself - the automated clock driven equally pulsed by the escapement mechanism, an oscilaltor literally counting - that is, *computare* - time, with a sense of temporal flow. Heidegger criticised the "digital" time produced by measuring media such as clocks. It was Aristotle, who in book IV of his *Physics* has defined time as "Zahl und Maß der Bewegung gemäß der Folge des Vorher und Nachher" - and as such as a function of numerical measuring. Heidegger opposed „vulgar“ mechanical time - as defined by Aristotle as countable, and objectified in the ticking clock - by „essential“ time <Heidegger 1927 / 1967: 421>. Countable time as represented by clocks are a form of periodic measuring, in the sense of the experimental order as developed in the natural sciences.

Ending as a function of memory *versus* endless delay

For any symbols and signals there is the problem of limited memory capacity, both in humans and in machines. At this point there is a rupture between semiotics and computing respective neurobiology: While symbols are timeless abstractions for notation, signals are physical beings which take place in time (the "real"). By signal processing in data modelling it is easy to gather a great deal

more information than can ever be represented in artificial, localized memory systems. The notion of infinite-state memory (and organizational memory) is familiar from systems theory, especially from the theory of adaptive filters. In this model, the parameters are *recursively updated* by all the received signals, whereby they can be regarded as a kind of memory for all received information. "It seems that the human memory <...> operates in this way" <Kohonen 1984: 21f>. On the other side, there is dynamic memories as developed for early electronic computing: (ultra-)sonic "delay lines" and "iconic" intermediary storage, the so-called Williams Tube, keeping pulse trains (which embody "data", bits respectively "words") in latent memory until they are used (addressed). The endless delay of the moment of ending is a chrono-rhetorical figure known in Christian religion as *katechon* (articulated by apostle Paul). Already in the world of mass media, starting with the original radio Soap Opera and culminating in television *serials*, the performance of end-less time, the time of endless deferral (the *katechontic*) has become a cultural form. "Siegecraft, once the art of defending the strategic cities of European states, has become the art of defending the archive" <Richards 1992: 124f>.

In many ways, recycling replaces the teleological direction ("sense") of ending - a temporal vector once scientifically objectified by the Second Law of Thermodynamics (entropy).

The "sense of ending" (Kermode) in narrative and music

In human physiology, there is no such locatable "sense of time" as it is manifest in the optic, the haptic, and the other biological senses. But still there is something like a "sense of time", but this experience of time (see Edmund Husserl, "inneres Zeitbewußtsein") does not necessarily involve a sense of ending since this is a specific product of narrative time. The decisive marks of narrated time are beginning, middle (or climax) and end, connected by a time-line on which the narrative unfolds towards the ending. Storage or memory time, on the oppositive, is "empty time", not dynamically unfolding, but invariant *stasis* <Großklaus 1995: 47>.

Narrative as a cultural form of ordered communication always already implies a sense of an ending. But the sense of (an) ending is not necessarily clothed in narrative form. Narrative (both as literature, as oral performance and as musical composition) carries the signature of its ending (a Kermodian "sense of ending") already from the beginning. "Music always knows the end", Ernst Bloch once described the narrative dramaturgy of musical composition <quoted after Richter 2003: N3>. What is speficic with musical time (with music counting as time-based art) is the time-critical mirco-dynamics of its temporal order, thus modelling temporality (German "Vergänglichkeit") as such. The human

perception of a melody takes place on the basis of a micro-temporal mechanism in consciousness, identifiable as neuronal correlation in the brain regions - a different, cybernetical drama unfolding below the narrative level, closer to mathematical counting (of time).

Linear time is characterized by sequentially unfolding, aim-directed events, with the singular events being linked causally to each other unfolding. The effect is the impression (and ideology) of a temporal continuum created by a succession of events in which earlier events imply later ones and later ones are their consequences <Kramer 1988>. Ludwig van Beethovens' string quartett op. 135, for example, initially performs this step-by-step integration of apparent divergent moments, linearly aiming at a *quasi*-Hegelian dialectical synthesis at the end). These processes give the movement a sense of forward motion through time.

Sonic temporality (somewhat inbetween physical acoustics and the cultural semantics of music) is conditioned on the one hand by the physical and physiological laws of acoustics, and by cultural training on the other. Kramer points to this cultural condition of this temporal aesthetics, as a function of the occidental philosophy of progress.[1] A process-oriented analysis of musical dynamics in occidental musical art reveals that is has been mostly directed towards an aim towards it unfolds progressively. Against this Eurocentristic temporality, Kramer describes non-linear temporal aesthetics - a "temporal continuum that results from principles permanently governing a section or piece", like known from the isorhythmic motette with its constant pattern of the rhythmical process (a "post-historic" condition). For several reasons - one of which is the technomathematical development of electronic media itself - non-linear time has become the dominant temporal figure in 20th century, where the dominant pieces of composition do not causally unfold any more, neither do they end in a harmonic, conflict-resolving *finale*. This non-directed linearity, "gestural time" (Kramer), is a semantic equivalent to media-technological *Eigenzeit*.

Writing and Time

The chrono-entropical directedness of physical (thermodynamical) time becomes "final destination" by the hypothesis of a discursive imaginary called history; *sense* (ital. *senso*) und *end* thus converge asymptotically. The frontispiece of Lafiteau's *Moeurs des sauvages Ameriquains* (1724) shows the encounter of writing and time in a closed space littered with relics from both Classical Antiquity and the New World. The muse of history (Clio) holds the pen, the allegory of time (Chronos) the scythe (in German:

[1] Hans-Ulrich Fuss, Musik als Zeitverlauf. Prozeßorientierte Analyseverfahren in der amerikanischen Musiktheorie, in: Zeitschrift der Gesellschaft für Musiktheorie 2/3 (2005); here quoted from the *online*-Version http://www.gmth.de/zeitschrift/artikel/205.aspx (accessed July 2009)

"Sense", another *senso*); both tools approach each other asymptotically without ever touching <de Certeau 1980>.

The idea of historical time, according to Vilém Flusser, is an implication of alphabetic writing which reduced the multidimensionality of architecture and images to linear, sequential lines. According to Marshall McLuhan, the invention of the printing press, i. e. the mechanized form of alphabetic writing as a further escalation, gave rise not only to perspective in Renaissance painting, but as well "print produced the idea of a past in distant perspective" <McLuhan 1962: 58> which is directional, end-orientated time. Historical consciousness, read this way, is the direct function of a specific media technology. The loss of historical consciousness as reference for the selection of information in combination with the increasing technological manipulation of time leads of the simple storage of all incoming data - starting with the E-mails on almost every private computer desk. The end of history is the future of the archive, a kind of post-historical condition not to thing in linearities any more, but to calculate with discreet states. Storage, according to the mathematical theory of communication engineering, is the pre-condition for all transfer.

The moment when facts are disseminated by news media, they gain a kind of kinetic energy which divorce them from their original context and throw them into hyperspace where they loose any pointed direction, de-referentialized, with no more teleology (which is the condition for the discourse of history as sense-driven narrative). When events are not only registered but as well written (~~historio~~-)graphically with no more sense of ending, what remains in the end are listings - a reduction of narrative to its essentials, like On Kawara's "date art" paintings. The artistic writing systems of Hanne Darbovens as well turn what used to be narrative historiography into lists of dates (e. g. *Bismarckzeit*, 1978): pure serial writing (corresponding with the computational *histoire sérielle* in the Franch school of historians around the journal *Annales*), pure description. Narrative elegance is being replaced by mathematical procedures of time series.

Game time

Live is not really, but only symbolically organized in *stories*; this sense-giving machinery gets in ekstasy when the end of narrative texts coincides with the expecation of the end of time (a sense of ending).

In traditional media the relation and distribution of linearity and non-linearity mostly converges with the patterns of narrativity. Narration produces in its classical structure of beginnging, midlee and end, a linearly unfolding sequence which allows for non-linear couplings, differering according to the

individual laws of media. While movies represent closed blocks of length, television developed the weekly series and its repetition. With hypertextual media (computer games, and the World Wide Web), non-temporal modes of beginning and end become aquainted: hypertime. The point and moment to step in is almost arbitrary.

Expressed in the mathematical theory of graphs, an adventure-computer game is defined by a beginning and an ending (almost „Homeric narrating“, according to Erich Auerbach): everything which happens between point *a* and point *b* in binary space partitioning.

While human memory remembers the same response to the same signal, a counting function counts it different each time <Spencer-Brown 1994: 65>. This is non-narrative time in action, replacing *raconter* (in French) by *conter*, disrupturing narrative (German "Er/zählung"). For the first time, in the so-called digital age historiography does not take place on the symbolical level of the phonetic alphabet exclusively, but on the level of electronically embodied alpha-numerics. In binary form the year 2000, f. e., appears as numerical string „11111010000“, reminding us not to be seduces by narrative suggestion, but to calculate in discrete states, with the consequence not to tell events intransitively but to count them transitively, quantizing data. The media theorist Lev Manovich (in a chapter of his book *The Language of New Media*) calls this the aesthetics of data banks, corresponding with a data-archaeological information ascetitics. Beginning and end, in computing media, are not structured by dramatical structures any more, but dramaturgische Struktur, but by the (equally complex) logic of *count down*.

The "Y2K problem" and the non-sense of ending

In spring 2009, I received per e-mail a strange message sent from the computing service of my university (Humboldt University, Berlin): The storage capacity of my account was close to overload and memory capacity will expire soon. Having passed the first moment of astonishment, my assistant (Felix Pfeifer) pointed at the date indicated for this temporal limit: "1.1.1970" - the beginning of "system time" in IBM computers. This apparent joke nevertheless is indexical for the being-to-death of computing time.

Almost ten years ago, a computational problem (both in Arno Borst's sense of medieval *computus* as time-counting and in the sense of mechanized data processing) almost led to a collective panic for the so-called post-industrial information society: the *millenium bug*. The so-called "millenium bug" reminded our information society of its very temporal being-to-death. There is a close connection between the temporal, destinational logic of

narrative texts and apocalyptic expectations. Most computers so far had been programmed in such a way that the step into the 21st century - without laborious intervention - meant a jump back in time, so the 1st January 2000 was indicated as the 1st January 1900. The reason for this lied hidden deep within the operating system - a media-archeological *deep time*. The jump from 1999 to 2000 (in chronological time) as a jumping back to 1900 (in computational time) was not biased by philosophical musing on the ende of history any more, but has been triggered by integrated circuits. The computer-temporal bomb namend the Y2K problem reminded the post-historical society drastically that its temporal order is no more a function of philosophy of history but of data storage economy, since in the early years of digital computing memory space had been the most precious commodity. Thus the Y2K-problem turned out to be a function of the technomathematial archive to which the philosophical notion of "beginning" and "end" is alien. The *millenium-bug* thus turned out to be (like all katastrophies) a chance as well: the liberation from the cultural supremacy of narrative. With the "millenium bug", the mighty cultural engineering of calendar time turned out to be no more the priviledge of the church (like in medieval times) or of learned societies (like in the modern age). Calculating time turned out to be a technical historicity from now on - a temporality to which human concepts of time are increasingly subjected <Baudrillard 1990 / 1994>.

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"Ubiquitous oscillations" *versus* transient phenomena: Signals of ending in electronics

Active sonar in submarine communication creates a pulse of sound called a "ping", and then waits for reflections of the pulse. The time from emission of a pulse to reception is being measured, traditionally by use hydrophones to measure the relative arrival time to each in a process called <Wikipedia>. The ping signal, when fading out, resembles the outfading oscillations in early spark-driven telegraphy which was turned into stabilized, continuous oscillations only by the electronic vacuum tube in feed-back circuits. Only this allowed for the transmission of carrier-wave-modulated speech and music, as opposed to discreet Morse code. Let us compare this with the process of a swinging string. A pulled string at an instrument with a fading pitch anticipates the infinite swinging out from the sudden, *transient* start. In the real, that is: physical world the picked string fades out during to mechanical loss of energy (Heidegger's "being-to-death" in its mechanical sense), like a swinging pendulum, like the echo in the sonosphere. In 1948, Dennis Gabor criticized the idealism of harmonic Fourier analysis: the hyothetically endless and beginningless periodic waves miss the temporal (eventual) aspect of a sound happening in the world, for example a key stroke at the piano, or a string touched - that is, the moment when an idealized model becomes an event in the real, that is: temporalized world. It was the temporal delay manifest in echo acoustics which already led Aristotle to the hypothesis that there must be a resistant "inbetween" (in this case: the air) which functions both as a carrier and a restistance to the propagated sound - *to metaxy*, giving birth to the first genuine media theory.

Both the pulled string and the articulated echo, by their very fading out, reveal the *endlichkeit* (the temporal limit) of any physical event. The moment a string is pulled or a sound is articulated, like a breaking wave, nature already anticipates and senses its very end, almost instantaneously but strictly temporal (like electromagnetic induction which is - as calculated by James Clerk Maxwell - very fast indeed but not instantaneous). In 1879 Hermann von Helmholtz initiated a prize by the Berlin Academy of Sciences to answer the dispute on the essence of electricity: the theory declaring no wave-like transmission but rather an immediate reaction (in the tradition of Newtonean physics) *versus* Maxwell's

mathematical theory of electromagnetic waves as part of an encompassing electromagnetic spectrum like light, thus subject to temporality, a limited speed. Radio waves, as turned out by Heinricht Hertz' experiments on the very media-archaeological level (that is, before becoming part of a mass-medium called "radio"), have a *sense of ending* on the very electrophysical level; the secondary level is the modulation of the carrier waves by the proper radio program which by its very format nature is ending by arbitrary cultural and media-economical decisions.

Time-to-live and ping-to-death: Internet temporality

There is a "semiotic" use of signs of ending on the micro-temporal level which is the operative temporality of electronic media: linearities which are nevertheless not narrative, and discontinuities which are the precondition for what human physiologically perceive as continuous movement in space (the kinematographic effect). The electronic (analog) image on the television screen is being scanned by the scanning finger of the cathode tube ray line by line. After such a line has been completed, a special signal indicates the cathode beam to jump back to write another successive line. A different kind of synchronization impulse indicates the completion of whole image frame, to start anew.

The programming of computers always involves a local sense of ending, since it has to pay respect to the time-critical question of data-synchronisation. When a code is literally "run" by the machine, a so-called *profiler* finds out how long the machine takes for the respective operations. A similar time-critical mode is true for communication in the World Wide Web. The ICMP protocol operates on the basis of echo request and echo reply. The source computer sends small data packets of the type echo request to the destination computer. In case these packets reach their destination, it replies with the type echo reply; thus the data connection between two machines can be chequed and disturbances be detected. But these control data can be misused, leading to the so-called "ping of death" and ping flooding. "Ping of death" stands for oversized data packets which once lead some TCP/IP stacks to collapse, destroying the machine configuration. "Ping flood" means the echo requests are being targetted with the highest possible speed; the destination computer thus is so busy with answering that he can almost not be used for its poper tasks any more.

What happens in the computational background of "Ping Timeout"? Between the local PC and the IRC server keep-alive-singals are being sent back and forth: the "pings". When no answer occurs within a certain pre-defined temporal interval, the line is being set back automatically. The whole procedure can appropriately be called a Ping-Pong game. In TCP/IP as fundamental network program,

techniques of synchronisation meet a deadly economy of time. "Time to live" means that each daten packet is assigned a given life span; "Time to die" stands for the crucial signature of the information age <Gießmann 2009>.

A mathematical anticipation of ending

Techno-mathematics operates in an *untimely* mode (to make use of Friedrich Nietzsche's German notion of "unzeitgemäß"). Oswald Spengler starts volume I of his classic *Untergang des Abendlandes* with his notorious chapter on "The Sense of Numbers" <Spengler 1923>. He criticizes modern "Faustean" science for its emphasis on mathematical laws of causality which do not catch the unpredictability of life which is rather a function of destiny. According to Spengler, future live can be *sensed,* but not calculated. Soon after Spengler, Western science managed to cope even with destiny and unpredictability in mathematical terms: linear prediction by stochastic calculation and harmonic analysis, as developed by Norbert Wiener. Linear prediction (which in linguistic grammar is *futurum exactum*) pracitcally means the anticipation of the past in the future. This *chronotopos* of "past in the future" has been developed as a mathematical tool for anti-aircraft artillery in the Second World war, leading from the analogue computer (Vannevar Bush's Differential Analyzer) to the first electronic computers.

With anticipatory targeting (known from human "musical" perception, such as melody recognition as analyzed by Henri Bergson as much as by Edmund Husserl), such a directional "sense of ending" opens a temporal horizon, in fact: it temporalizes the apparent momentary presence into an augmented presence. What has been described by Edmund Husserl (examplified by the human capability to grasp a musical melody) as "inneres Zeitbewußtsein", a temporal horizon consisting of re- and protentions, has become technomathematical in real-time computing (since the stored program computer, the so-called von Neumann architecture of computing) which - seen under that aspect - is "musical" in character. Indeed, this form of temporal integration is known from human physiology and in linguistics, when it comes to (Husserlian) semantic pro- and retention in sentence-building, such as the backwards-correction of the meaning of a word. A similar phenomenon is the perception of a musical melody when there is discreet sonic pulses in (physical) reality. Each attentive perception involves always already an expectation, resulting from the evaluation of what has just be perceived by mixing it with the memory of previously perceived impressions. Thus during the so-called psychic time of presence the immediate future is already being calculated. "Bergsonean time" (as mentioned in a chapter of Norbert Wiener's *Cybernetics*), which is the experienced event time (*temps durée*), differs from the physical time in science (*temps espace*). Is it therefore - referring to Husserlean phenomenology -

an anthropologically (or better: neuro-physiologically) grounded tendency to predict from past events a future behaviour of time series. In the case of music, the cognitive hypothesis states that the physically heard signals will be reproduced in one way or the other in the immediate future ("Protention"). It is such projective fields which account for an impresison of regularity - a role traditionally ascribed to the abstract notion of prescribed metrum <Hasty 1997>.

Sensors for targets (rockets, trajectories)

The meaning of the end and the sense of ending are closely coupled. There is a complex and controversial relationship between the ideas of the end and of sense, with "sense" here referring to the physiologically sensual (neurologically and electro-technically) signal-based, but to "meaning" as well - an ambivalence kept in Italien (*senso*). Let us look at the plurality of semantics. Latin *finis* means border, limit, end, achievement, goal, final aim, purpose, equivalent here to Greek *telos*. It has been a technological paradigm of 20th century communication theory, in fact *cybernetics*, which gave a hitherto metaphysical notion an epistemological twist for both humans and machines, as expressed in Norbert Wiener's writing on "Behaviour, Purpose, and Teleology", cultivating a non-deterministic, still teleologically orientated theory of feed-back <Wiener 1943>. Between target and destruction, on one hand, *finis* means end and ruin, whereas, on the other, result, achievement, aim. This polysemanticity is kept in Italian, but as well is resonant in elaborate German language, f. e. in G. W. F. Hegel's notion of the "end" of art ("Ende" here equals "Vollendung", fulfillment).

Military techno-mathematics is less metaphorical here, or expressed the other way round: it is literally metaphorical (with "metaphor" naming "transfer"). Archytas of Taranta once explained acoustic sound kinematically: a really media-archaeological, process-orientated explanation indeed. His kinematic (or dynamic) description of sound as crash of objects with air most probaly results from the poetic notion of the voice as missile <Khaled 2006>. Archytas recognized the essence of sound from its temporal nature (and thus its frequency *avant la lettre*), analyzing that higher sound (the pitch) results from higher speed. In ballistics, the final destination has been a function of mathematical calculation, giving rise to a plethora of new methods. A shell [Geschoß] has to be imbued with an in-built "sense of ending" in order to arrive at its planned destination, culminating with the German V1 rocket in World War II and its pre-calculated trajectory. With the V2 rocket a further escalation happened: A self-correcting mechanism (a kind of Analog Computer, the in-built "Mischgerät") was able to correct aberrations during the trajectory ("on the fly") - a technomathematical sensorium of ending. We know the image from Iraq War II: The ending of the

trajectory is the final hit of the missile which corresponds with its self-destruction, as expressed by the title of David Mindell's Ph.D. thesis in 1996 (Cambridge, Mass.): *Datum for its Own Annihilation*. But still, the trajectory is planned to be more or less linear and allows for linear prediction.

An epistemologically more delicate situation arrives with the anti-aircraft artillery in WWII, when the "enemy" pilot is expected to try to manoeuvre around the artillery trajectories. The artillery thus has to anticipate not only the immediate future position of the enemy aircraft, but as well the possible counter-manoeuvres of the pilot to escape this linear prediction. For that reason, a modification of the trivial pre-calculated fire tables has been developed which lead to the rise of a mighty technomathematical tool: the electronic analog, then: digital computer. The Mark 1 Ford Rangekeeper on a battle-ship in World War I had the purpose to calculate *in real time*, that is: in the medium of temporality itself (as the only stable variable) the enemy ship's course and speed, to extrapolate these data into the future, and the to aim where it was expected to be: a mathematically "calculated" sense of ending, embedded within a mechanic analogue computer. If one entered an inital range, the machine calculated the range into the future. A similar mechano-mathematics was applied in the later Sperry T-6 anti-aircraft director. "The computer performed <...> *prediction*, or leading the target, modeled its motion and extrapolated it to some time in the future" <Mindell 2004: 20>. The figure of time here is the grammatical future-in-the-past, based on a feedback operation: The director multiplied the calculated velocity of the target by the prediction time "to determine a future target position and then converted the solution back into polar coordinates for output" <ibid., 89>. Thus the machine represented a worldly, that is: timely process by a physical model. In order to do so, the classical firing table data were mechanically fed into this computer as a kind of permanent memory, "roughly comparable to what today we would call *ROM*, or read-only-memory" <Mindell ibid.>. Ballistic and prediction calculations formed a feedback loop, with the aim of minimal dependance on the so-called human element.

A photography of a German rocket attack, reproduced in Mindell's media-archaeological analysis, shows continuous and discrete signals agonistically coexisting in the air - the anti-aircraft-system shooting down a buzz bomb. The missile enters at the left, is hit by a shell, crashes, and explodes. The white dots are shell explosions, which continue to statistically track the predicted position of the target" <Mindell 2004: 256>. This is the appropriate moment for this text to end - or should I write: STOP?

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