RECURSIONS

Sonic Time Machines

Explicit Sound, Sirenic Voices, and Implicit Sonicity

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Amsterdam University Press

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For the book cover, the author articulated SONIC TIME MACHINES for electric recording, and from that sound file, a wave form oscillogram and a spectrogram have been produced which serve as a background diagram for the typographical title, to suggest the passages inbetween 'analog' and 'digital' sonicity in a not just metaphorical, but rather self-expressive way.

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Content

Preface

This book investigates the manifold existence of sonic articulations *in* and *as* time: its explicit tempor(e)alities in the techno-cultural context and its implicit dynamics as object of knowledge.[1] Phenomena ranging from resonance to signalling in recording and transmission technologies can be conceptualized in their temporal essence as inherent *sonicity,* even if their engineering (such as coding or compression) do not always directly relate to cultures of listening and the audible. The method of research applied here is media archaeology, which closely investigates artifacts *and* 'listens' to the time-critical and chronopoetic conditions (ancient Greek *arché*) of their operativity. Sonic terminology turns out to be most appropriate for describing such technical temporalities for which historical discourse is no longer sufficient.[2] When sonic communication is not reduced to acoustics in the narrow sense, but understood as signal events (be it continuous 'analog' wave forms, be it discrete 'digital' impulses), even vibrational events in optical physics can be identified in their processual sonicity. Differentiating between the acoustic, the sonic, and the musical, the aim of this investigation is to apply such notions for a better understanding of the deep epistemological dimensions of media temporalities.

The following arguments result from an ongoing research focus on the affinity and privileged alliance between technological media and musical sound, based on the assumption that their common denominator is temporal processuality.[3] Such investigations on sonic media tempor(e)alities and sonicity in its physical, cultural, and technological sense have been inspired by the unique academic umbrella of otherwise separated disciplines, the Institute of Musicology and Media Studies at Humboldt University, Berlin. I am grateful to my colleagues Peter Wicke and his assistant Jens-Gerrit Papenburg for the initial impulse to explore *Das Sonische* and ongoing discussions on the subject.[4] Special thanks go to Jussi Parikka for many reasons; it was he who originally suggested composing this monograph in English. Further gratitude goes to Jan-Claas van Treeck for a critical reading of my manuscript, to an anonymous reviewer for concise suggestions, and to Liam Cole Young for helping me to polish my English. All stylistic and argumentative idiosyncrasies, of course, remain my responsibility.

Printed texts necessarily exclude sound matter – even if, in a deeper sense, there is implicit sonicity in diagrams and graphs that are derived from sound sources. Media-archaeological purism in this book resists the temptation to use substitute imagery. The question to what degree a sonagram

(spectrum analysis) or sonogram (ultrasound-based visualization) keeps an indexical relation to the measured event would lead to a debate worthy of a new book in itself.[5]

1. Introduction: On 'sonicity'

'Sonicity': Arguments for a modest neologism

Inquiries into *sonicity* should not be confused with Sound Studies. Acoustic sound is the section of the bandwidth of waves and vibrations mechanically transmitted through a physical medium that is audible to humans. Acoustic sound compares to the deceptive top of an iceberg visible above water, whereas electronically generated high frequency oscillations are of a different nature.[1] These 'waves', which are familiar from radio transmission, correspond to the part of the electromagnetic spectrum that animals immediately perceive as 'light'. Sound in its generalized sense as temporal enunciation refers to continuous ('analog') and discrete ('digital') vibrational and frequential dynamics of all kinds. These range from the most precise (electro-)physical micro-mo(ve)ment related to the human affect of temporal perception, up to culturally emphatic modulations[2] – similar to the so-called Projection Theatre in Revolutionary Russia of the 1920s, which grounded body movements in the epistemology of soundings: 'The sound is not heard, but formed. Practice: independent Translation of muscular sensation into a body: A O U I E.'[3]

Sonicity is where time and technology meet. Technosonic time-mechanisms and their charming power to seduce the human sense of time deserve a study of their own. If time is neither reduced to an internal state of subjective consciousness nor to an external physical *a priori* but conceived as a complex layering of the imminent, of presence and of past(s)[4], rich forms of temporal articulation can be identified in a chrono-tonal sense.

This study does not refer to time machines in the sense of H.G. Wells's mechanical device for time travelling;[5] sonic tempor(e)alities are everything but metaphoric. They can rather be expressed in terms known from the epistemology of the electromagnetic field.[6]

Even the emphatic concept of cultural time – which in narrative writing is organized in the name of history – is affected by the sonic approach:

> To understand the ways that media inscribe themselves on our bodies, we need a philosophy of history that recognizes the production of a "new already". [...] Before the phonograph, no sound had the option but to be fugitive. A historical rupture in the nature of sound arises that, in turn, rewrites its entire history.[7]

But maybe this irritation is more fundamental: not just a historical rupture, but a rupture of the dominance of historical discourse over the phenomenology of emphatic time as such. The generation of vocal or even musical 'presence' deriving from a source that is cognitively known to be absent, as induced by the phonograph, does not simply ask for a rewriting of media historiography, but requires different ways of writing temporal figurations as such. Such a project calls for the kind of archaeography that has been performed for decades by the oscilloscope's visualization of sonic wave forms.

Sound and music let us experience transient time. It is this processuality that the sonosphere shares with high-electronic media. Just as musical culture tries to save sound itself from ephemeral temporality (favouring invariance), signal recording media for the first time in cultural history mastered the time axis, thus enabling arbitrary manipulation and repeatability. Phonographic recording is not historiography but signal storage.[8] Any such graphic trace of an acoustic event cannot be considered sound. The *implicit* sonicity of an acoustic event depends on a temporalizing medium like the record player to make it *explicit* through time-sequential unfolding, just like cinema needs the projector to restore movement to otherwise discrete chrono-photographical film frames.[9] Recording does not take place in or as historical time, but is a time operation itself. This makes it a privileged form of investigating tempor(e)alities.

Sonicity as a neologism is meant to be kept apart from acoustic *sound* and primarily refers to inaudible events in the vibrational (analog) and rhythmic (digital) fields.[10] *Sonicity* is intended to sound awry so that it is differentiated from sound, a culturally familiar term that is academically somewhat restricted to musicology. Sonicity names oscillatory events and their mathematically reverse equivalent: the frequency domain as an epistemological object.[11]

Musical theory in the occidental tradition continued the Pythagorean epistemology of harmonic calculations. Sound is thus not perceived as the sonic event in itself but becomes a phenomenon of mathematics in the widest sense of the symbolic regime. But actual sound is implemented mathematics *in performance*, integrating space, time, and matter. Early experiments with 'drawn sound' led to a remarkable chain of conclusions that anticipate the concept of sonicity:

> Graphical representations of the sound wave could be analysed and represented as a Fourier series of periodic functions (sine waves). Consequently, the sound wave could be re-synthesized back with the same set of sine

> waves. […] As with electrons […] the number of which defines the quality of the atom, so do sine waves define the quality of the sound – its timbre. The conclusion: why not initiate a new science – synthetic acoustics?[12]

With the relatively primitive circuitry of an oscillator-driven series of flashing LEDs as an operative diagram, one can simulate the swinging of electrons around an atomic kernel that radiates in pulses. The visual transition of discrete pulse trains into an impression of continuous waves is implicitly sonic. This is not just a metaphor but an essential emanation of electronics itself. The technical impulse diagram reveals the coming-into-existence of this electro-rhythmic sequentiality. Two elementary qualities of sonic articulation (electrified rhythm in impulses and continuous waveforms) do not belong to different worlds but can be revealed as interrelated phenomena. Longitudinal waves make the molecules of air or water swing in the direction of the propagation, while the periodic waves themselves can be mathematically counted in symbolical frequencies in reverse. The interlacing of matter and number in sound takes place on the most elementary level.

In its non-human embodiment within electronics, a special subclass of sonicity is *sonics*. This is meant to name sound that does not originate from physically resonant bodies but from electro-technical and techno-mathematical processes. These become audible at all only by explicit sonification. Otherwise, *sonics* exists in electronic latency like songs and voices recorded on magnetic tape prior to playback. Speech recorded on magnetic tape is not just 'electrified voices'[13] but a re-definition of the voice itself. At first glance, a familiar motive known from cultural analysis re-appears with the 'humanized' voice. This motive is hidden in thick layers of the techno-aesthetic apparatus: that most media technologies still circulate around the human in the anthropocentric mode. In contrast, revolutionary Russian experiments in technological sound intentionally aimed at de-humanizing the voice.

The term 'sonicity' does not primarily refer to the apparent phenomenological quality of sound, but rather to its essential temporal nature, which is its subliminal message behind the apparent musical content.[14] Nicole Oresme's late medieval *Tractatus de configurationibus qualitatum et motuum* defines the 'sonus' in its physical materiality as a function of the time axis[15] and thus comes close to the present definition of sonicity as epistemic articulation. The etymology of *sonus* ranges from the concrete physical materiality of sound up to its epistemological definition[16] for which the retro-neologism *sonitas* might be allowed.

Techno-cultural dimensions of sonicity

In a sublime rather than noisy intervention, the concept of sonicity questions the supremacy of the visual in occidental aesthetics and knowledge. The impact of sound and aural operations, especially in their non-musical variants, has long been under theorized. A major feature of the relationship between visibility and audibility is that they have markedly different temporalities. Western cultures have been predominantly visually oriented in their ways of information processing – an effect of the reading, writing, and printing culture that privileges transmission and absorption of information via the optical channel of communication.[17] It was not until recently that an 'auditory turn' was declared in the humanities and aesthetic practice. The past neglect of the acoustic dimension originates in visually-oriented media studies, which as an academic discipline stems either from philology's privileging of the eye as information absorbing channel (i.e. reading), or from film and TV studies. In order to focus on the practices, aesthetics, technologies, and concepts of sound, noise, and silence,[18] it makes sense first to differentiate between *music* as a heavily semanticized cultural art and the *sonic* – which, while culturally conditioned, is also a function of psycho-physiological perception. We must also, then, factor in the materiality of (electro-)acoustics as (techno-)physical event.

In the symbolic order of musical notation, so-called structural listening can take place in the mind through intelligent score reading without the physical presence of an external sound source. As once conceived by Theodor W. Adorno, 'the silent, imaginative reading of music could render actual playing as superfluous as speaking is made by reading of written material.'[19] But it *matters* that sonicity takes place as a physical vibrational event that is distinct from mere symbolization. It is academic commonplace now to claim that the socio-cultures of hearing and the sonospheres of listening have been extended by the impact of technical media in modernity.[20] A true media archaeology of listening is not limited to acoustic phenomena but also takes listening in its hermeneutic and even epistemological sense as *understanding*. Sonicity (understood here in its neologistic sense) differs from a simply physical notion of sound (*Klang*) because of its strict dependence on physical or technical embodiments and algorithmic implementations. In audio recording, the forms of electronics make a difference.

By considering technologically induced delays and manipulations of the sonic time axis, media archaeology furthermore questions the 'sound' of tradition. Questioning the historicity of musical articulation leads to a discussion of affects related to time-invariant presence that result from the

technological reproduction of sound – archiving presence and re-presencing the archive.[21] Active media archaeology remembers past sonospheres by technical means. Listening to the archive in such ways not only produces unexpected audio recordings and other revelations of the sonic past but also new forms of articulation (sonification) for recordings themselves. Listening to modernity, conceived as sound from the archive, does not simply expand source material available for research into for cultural history, but leads to a different modelling of cultural time in terms of resonance. The message of the media of modernity is 'acoustic space' (McLuhan). A privileged alliance between sound events and operative media reveals the moment that their common denominator is detected: both come into being only when being in time.

Implicit sonicity: 'Acoustic space' (McLuhan)

Since the emergence of phonetic writing, knowledge has been primarily connected to an act of seeing; 'idea' and the 'visual' stem from the same etymological root *vid*.[22] Ancient Greek *gignóskein* (the creation of an object by the very act of recognition) can be traced back to seeing and the eye. But with the telephone, gramophone, and analog radio a non-visual and post-literate acoustic space took off. Marshall McLuhan defined the immediacy of electricity as the definitive difference from the Gutenberg world of scriptural and printed information:

> Visual man is the most extreme case of abstractionism because he has separated his visual faculty from the other senses [...]. [...] today it is threatened, not by any single factors such as television or radio, but by the electric speed of information movement in general. Electric speed is approximately the speed of light, and this constitutes an information environment that has basically an acoustic structure.[23]

We are therefore, McLuhan declared at the climax of analogue electronic media culture, back in acoustic space. *Acoustic* space is understood here not in its physical sense but as the epistemological existence of sound.[24] When McLuhan made his crucial discovery about the intrinsically acoustic structure of electronic mediascapes, he implicitly co-defined *sonicity*. Whereas physical sound establishes a mechanical, haptic, and tactile coupling between the material source and the human receiver through a vibrating medium (be it hard matter, water, or air), a sonic articulation, once transduced by an electronic device into variations of electric voltage, has an intermediary spatio-temporal *in between* existence. Within an electronic

system, sound exists implicitly. While a media-archaeological device of early electro-acoustic instruments, the Mellotron, reproduced sound by single tone 'samples' recorded on magnetic tape stripes attached to each key, primordial 'electro-acoustic spaces aren't simply a genre of music […] – they are interfaces with the machine […].'[25] Human perception is not affectively absorbed by musically semantic content anymore, but by the medium's very technological message – by assimilation to the medium itself. 'Anyone who wishes to receive a message embedded in a medium must first have internalized the medium […].'[26]

McLuhan's notion of an implicit acoustic structure media-archaeologically refers to an epistemological ground, not to the acoustic figures ears can hear. This groundbreaking took place with the collapse of Euclidic space into Riemann geometries and culminates around 1900 with the quantum physical wave / particle dualism.[27] This has led to the 'superstring' theory of contemporary physics, which borrows from operative sounding to name vibrational dynamics as universal ground – the Pythagorean monochord.[28] The equation of world and number in terms of musical harmonies turns musical instruments into analog computers of a kind that model laws of temporal order in the physical world. This insight comes into being either by historical transmission of cultural knowledge or by original knowledge generated from within the sonic techniques themselves. This resonates with the epistemology of music in Indian culture. Additive Western music builds up synthetically, with its base being silence, whereas subtractive Indian music actually begins from sound.

> All the notes and possible notes to be played are present before the main musicians even start playing, stated by the presence and counting of the tambura. A tambura is a drone instrument […] that, due to the particular construction of its bridge, amplifies the overtone or harmonic series of the individual notes in each tuned string. It is […] continually present throughout.[29]

This extends to the concept of non-struck sound like the theoretical fiction of vibrational forces called 'ether'.[30] Sonicity refers to, on the one hand, sonic knowledge that is implicit within instruments of sound analysis and synthesis,[31] and, on the other, graphically or mathematically derived sound.[32]

Once the tuning of such string instruments is extended beyond musical (harmonic) aesthetics to sonic techno/logies (in two senses, as an electronic measuring apparatus and a mathematical modelling of the temporal dynamics of the vibrating string),[33] integer numbers representing

well-ordered harmonic relations between tones dissolve into infinitesimal sub-graduations. At that point, musical theory (which since Pythagoras has been pushed to its limits by well-tempered tuning) has to be replaced by the epistemology of sonicity.[34]

The essence of McLuhan's term 'acoustic *space*' is that oscillating *time* functions in the same way that the spatial interval turns out as a negative sound: silence.[35] In an epistemological sense, *sonicity* is not primarily about or limited to the audible, but is a mode of revealing modalities of temporal processuality – just as technology is 'a way of revealing' essential features (*archai*) of handling the world.[36] To some extent, hearing is a memory, but in ways radically different from static storage and the archive. Reverberative sonic memory challenges the symbolic order of the archive. Thereby the philosophy of history itself is provided with a question mark. In *The Presence of the Past* (1988), Rupert Sheldrake proposes a theory of evolution that is not based on historical development any more but on electromagnetic resonance.

Phonovision and the sonic nature of the electronic image

Henri Bergson in *Matière et Mémoire* (1896) formulated an idea of dynamic matter as 'image'; this is meant not in an iconological but a sonicistic sense, as vibrating waves and frequencies.[37] Ironically, it is not acoustic sensation, but human eyes that come closest to a radio detector of sonicity in their ability to perceive non-mechanical, ultra-high frequency electromagnetic waves called 'light' and 'colours'.

Information coming at the speed of light simultaneously from all directions (different from asynchronous communication in online worlds) recalls the structure of the act of *hearing*. Recalling McLuhan, the *message* or effect of electric information is acoustic – even when it is perceived as an electronic image. In fact, the sonic ground of the electronic image is 'hidden' in the media-archaeological and Heideggerian sense of ancient Greek *aletheia*: 'It is acoustic. It resonates. But this is a hidden ground, because superficially people think they're looking at a visual program. And they're not. They're not looking at all – they're absorbed, involved in a resonating experience.'[38] Such immersion is into a *sonic* (rather than *acoustic*) sphere.

A synthaesthetic transfer and an audio-visual metonymy take place when the time-critical video image is discovered in its 'vibrational acoustic character.'[39] This is not a theoretical, epistemological or philosophical supposition but a media-archaeological truth: 'Technologically, video has evolved out of sound (the electromagnetic). Its close association with cinema is misleading since film and its grandparent, the photographic

process, are members of a completely different branch of the genealogical tree (the mechanical / chemical).[40] The inherent sonicity of the video image is reminiscent of the deep media-archaeological link between the television signal and telephonic voice transmission. The transmission of sonic articulations over distance served as technical *a priori* of television; this implicit techno-structural affinity became manifest in the development of the Picturephone by the Bell Laboratories.[41]

There are technological settings in a laboratory that serve as the apparatus from which knowledge emanates.[42] In reverse, from a media-archaeological point of view, there is knowledge materialized, embedded, and implemented within operative media themselves that deserves to be extracted and derived by explicit academic inquiry and verbalization.[43] This can be illustrated with the so-called Phonic Wheel (*Phonisches Rad*) as an individual element in the otherwise optically oriented early electro-mechanical image transmission Nipkow system.[44] This electromagnetic 'phonetic' wheel inside the apparatus is meant to synchronize the image lines between transmitter and receiver – a kind of *tuning* by *resonance*. The sonic is implicit, with no sound to be heard, as chrono-technical sound knowledge (sonicity). Visible tuning takes place with the stroboscopic disc (attached to the Nipkow disc), which is on the front side ('interface') visible to the user and parallel to the actual television image. The message of this medium process is *timing*.

John Logie Baird's *Phonovision* technology, developed in 1927/28 for his electro-mechanical television system, allowed for the recording of low-resolution images (12.5 frames of 30 lines per second) on gramophone records. Amplified and connected to a loudspeaker, the time-varying electric signals – transformed from light impulses by a photocell – were within the human audible realm and could indeed be transmitted line by line via medium wave radio.[45] That induced the idea of *quasi*-phonographic recording; video recording *avant la lettre* transformed electric images into sonic temporality. In Baird's *Phonovision* recordings, audio is the original vision signal.[46] Different from the cinematographic image, the classical electronic TV image is closer to sound due to its one-line scanning. The auditive is thus *immanent* to the electronic image in a sonicistic sense.

Human perception when confronted with electronic images from cathode ray tubes is affected in its subliminal temporality, a parameter that is otherwise located within the auditory system. In reverse, the electric 'reading' of graphic inscriptions on celluloid and their transformation into electric signals by the photo cell allowed for sound to accompany discrete photographic image series in movies.[47]

The earliest known recording from a television program is the revue *Looking In*, performed by the Paramount Astoria Girls on the BBC Baird television system in April 1933, recorded on aluminium disc by an enthusiastic amateur using the Baird Phonovision system.[48] Processed and restored by digital filtering, the cue to clarity seems to be movement itself. Any photographic reproduction of one of the 30-line television broadcast stills in a book as illustration gives a wrong impression of what was actually perceived. Here, the time-critical argument comes in, since printed records (be they texts or images) miss a crucial element: *passing* time. The human brain builds up a dynamic model of what eyes might actually discretely look at. This process is remarkably close to the cognitive synthesis of musical melody recognition against acoustic perception, as analyzed by Hermann von Helmholtz:

> A single frame of the Paramount Astoria Girls may be crudely recognizable, but when seen as a moving dynamic television image, the girls come to life before our eyes. […] it has much more to do with what we perceive than what is there in pixels, lines and frames. What we are experiencing is not the detail that the eye sees, but the recognition of movement that the brain sees.[49]

Similar to Jean-Luc Godard's notion of the *son-image,* Bill Viola explicitly identified the sonicity of the electronic image.[50] The video camera, as a transducer into electrical impulses of varying light input, 'bears a closer original relation to the microphone than to the film camera.'[51] Viola comes close to McLuhan's notion of *acoustic space* as describing the chrono-epistemological background of electronic communication. The signal regeneration of television or computer images on a CRT monitor is a form of *implicit* sonification, since the electromagnetic waves emanating from such transduction can easily be detected by an aptly tuned radio receiver.[52] Such a sound turns into (algo)rhythm when it comes to eavesdropping on digital images[53] somewhat akin to the electro-chemical transduction of light in human eyes when communicated in pulse trains to the brain. Sometimes technology *resonates* with human perceptual modalities in a privileged way.

The Berlin Dada artist Raoul Hausmann oscillated between synaesthetic metaphor and technological precision with his construction of a light-to-sound converting *Optophon*.[54] But apart from trivial archaeological metaphors, the epistemic level of sonicity is reached only by uncovering its implicit dynamics. In 1932, Boris Yankovsky from the Moscow Graphic Sound group refrained from optophonic metaphors since he was not simply

a sound-imagining artist but also an acoustician. He founded his own Syntonfilm Laboratory in Moscow based on media-operative insights into the genuinely time-critical nature of sound waveforms. These he conceived as temporal transitions contained in the dynamic sound spectrum 'instead of monotonous colouring of stationary sounding fixed geometric figures (wave shapes)'[55] – even if he admitted that the nature of this phenomenon was not yet completely clear to him. Sonicity remains implicit. 'The premises leading to the expansion of these phenomena – life inside the sound spectrum – give us the nature of the musical instruments themselves [...].'[56] Such observations are close to contemporary Physical Modelling. The mathematical approach (Fourier analysis) and 'graphic sound' of a different kind – namely sonagrams as the diagrammatic expression of dynamic development of the sound spectrum in time – uncover the epistemic layer of sonicity in sound itself. According to Jean-Babtiste Fourier's *Analysis of Heat,* any periodic expression can be decomposed into its single sine waves, which – in reverse – can be computationally addressed as frequency, i.e. numbers. Sound is thereby understood as addition of tones. In implicit sonicity, kymatics and mathematics converge: '*Plusiers questions de mécanique présentent des résultats analogues, tels que l'isochronisme des oscillations, la rèsonnance multiple des corps sonores*.'[57] The sonicistic approach is not restricted to audible sound; electronic images are techno-mathematically analysed and digitized for compressed transmission in the same way.

Not for human ears: Ultrasound and radar

On a more fundamental level, a decisive feature of culture is its wilful creation of unnatural sounds. On the one hand, such sounds are bound to traditional arbitrary articulations like speech or singing and are typically generated by the human body and/or musical instruments. Tonal and impulse-like articulations generated by electronics are not simply an escalation of traditional sound, but testify to an epistemic rupture – from sound to the sonic, as Stockhausen insists.[58] These different, electron-based sounds embrace a much greater spectrum than what human ears can acoustically perceive. The very term ultrasound is still anthropocentric – defined by the upper limit of frequencies that provoke an acoustic sensation within *human* hearing. For sound beyond this acoustic threshold to be perceived by humans, it takes deceptive sonic transpositions or signal transductions such as the *imaging* of ultrasound. In such cases, what looks like a visual event in fact turns out to be a function of time-based sounding. Visual information is being unearthed by means of ultrasound. In order to generate such *imaging*, well known in medical diagnosis, the run time of acoustic

waves (echo delays, Doppler effects) is used to create electric signals that (after electronic amplification) can either be transposed down again to hearable sound or (aided by signal processing) be transformed into optical patterns. There is no organic co-existence of the binaural auditive and the visual regime in the perceivable world, but rather an alternating exclusion.[59]

At that point, ultrasound images, as known from clinical monitoring of the human organism, become an allegory of dynamic mediality itself. Ultrasound by definition transcends the realm of sound that can be recognized by the human ear (between 16 Hz and 20 kHz); it is rather part of what Marshall McLuhan named 'acoustic space': electronically mediated communication. Electro-technically-generated ultrasound waves belong to the world of aggressive mechanical oscillations, while at the same time are coupled to electromagnetic waves. In medical sonography, organic tissue fractures and returns high frequencies as echo to the sender, which can then be transformed into electric currents and encoded as numeric values by analog-to-digital transformers. This process results in a matrix that can be represented as a diagnostic image, a visual interface recognizable to humans. The medical gaze that has been analyzed as a discursive formation by Foucault thus turns out to be a function of the sonic. A sensitive apparatus algorithmically attributes the received resonant sonic signals to digital picture elements ('pixels'). The basic method behind this process is Fourier analysis, which identifies any kind of periodic signals as being composed of individual sine and cosine waves – a musical analysis that reveals the time-based essence of what finally looks like an electronic image. Ultrasound imagery reveals otherwise invisible structures using inaudible sound pulses – a technical answer to Martin Heidegger's understanding of ancient Greek *aletheia* ('non-hiddenness'). And at the most basic level of thermal oscillation within crystals, the energy packets are appropriately called *phonons*.

Media archaeology is not just a human mode of understanding technology, it is also a form of technical perception in which the technological device itself turns into a listening organ. The concept of sonicity is suspended from the privileged anthropocentric perspective in favour of its capacity for exploratory and open access to implicit sonospheres. Technical media provide a mode of listening (*hören*) prior to cognitive understanding (*verstehen*). In radar terminology, Round Trip Time names the travel time of the signal; in US naval jargon, *to ping* directly means to send a sonar impulse.[60] The vocabulary of sonar returns with implicit sonicity in the use of *ping* to describe a program that tests the time required to address an IP over the internet. In order to explore the physical properties of the

ionosphere, i.e. the *stratum* used for signal transmission in electromagnetic waves, 'the technique of sounding the atmosphere using radio waves is [...] remarkably powerful.'[61] The very terms *sounding* and *radio* are not meant in the mass media sense of listening to musical or vocal broadcast content. They instead refer to 'radio' in its techno-physical sense – the message of the medium (immediate radio) that discloses itself to the human ear most expressively in shortwave AM.

Transforming the sonic event into the mathematics of sonicity

Aristotle's kinetic theory of time does not assume its transcendental existence but explains it as a quantity derived from measuring motion, i.e. discrete cinematography. Time emerges from observing and counting motion. This corresponds with the mathematization of continuous sound in numerical terms of frequency analysis. The sampling and quantizing of acoustic signals analytically transforms the time signal into frequency information (Fourier Transform), which is the condition for technical re-synthesis. Bill Viola in 1990 pointed out 'the current shift from analogue's sequential waves to digital's recombinant codes' in technology.[62] Coded sound that is mathematical sonicity emerged from within the electro-acoustic synthesizer.[63] Erkki Kurenniemi describes his development of an electronic music studio in Helsinki in the 1970s with combined voltage and digital control: 'Digital signals were used as triggers or gate signals, and also as square-wave sound,' while the recording and editing of the final musical pieces still happened on analog full track audio tape.[64]

There is a countable dimension within each tone. Pitch is nothing but a cognitive metaphor for frequencies; each tone itself is a periodic time event. Karlheinz Stockhausen, in his 1956 essay '... wie die Zeit vergeht', described the chromatic tempo scale starting from the observation that 'pitch may be understood as the microtime equivalent of rhythm.'[65] Rhythm follows the same proportions as harmonies, only below the hearing threshold – a transformation of static geometrical relations into time events as sonic media diagrammatics. Already Ivan Wyschnegradsky concentrated on the musical tone from the acoustic point of view as a primarily rhythmic phenomenon, a sequence of impulses. This interpretation not only results in a panson(or)ic temporality of space but in a mathematization of the sonic event itself.[66]

The fact that 'Western music builds things up'[67] synthetically (culminating in the electro-acoustic synthesizer) is a direct result of the procedure of *analysis* that decomposes complex articulations into its elements. This started with the phonetic alphabet symbolizing speech in antiquity and

escalated with mathematical Fourier analysis, which decomposes sound into harmonically ordered sine waves – a sonic variance of logocentrism (with *logos* in ancient Greek naming numerical relations as well).[68] Current digitalization once more results in a radical transformation in the ontology of the sound record – from the physical signal to a matrix (chart, list) of its numerical values.

Beyond electronic 'acoustic space'?

Walter J. Ong emphasized that, in a culture dominated by the symbolic order of perspective, 'vision comes to a human being from one direction at a time.'[69] In contrast, when we hear, we 'gather sound simultaneously from every direction at once: "You can immerse yourself in hearing, in sound".'[70] Telephone and analog radio marked the technologization of post-literate sonic space (understood here as an epistemological form of cultural existence). Electricity's immediacy marks its time-critical difference from the symbolic world of scriptural and printed information. The epistemology of *acoustic space* corresponds with the ultimate modernist media spatio-tempor(e)alty. Notwithstanding his confusing electricity with electronics, McLuhan made a crucial discovery about the intrinsically 'acoustic' structure of electronic mediascapes. In a letter to P.F. Strawson, author of *Individuals. An Essay in Descriptive Metaphysics* (1959), McLuhan quotes from that work: 'Sounds, of course, have temporal relations to each other [...] but they have no intrinsic spatial characters.'[71] Sonic tempor(e)alities belong to an epistemology of McLuhan's 'acoustic space' – a sonosphere of electromagnetic waves that is currently being replaced by a digital immediacy of records. The result of this replacement is a geometrization of time, a spatiality which in mathematical terms is the topology of the internet.[72]

To what degree is the internet 'sonic'?

'At the speed of light, information is simultaneous from all directions and this is the structure of the act of *hearing*, i.e. the *message* or effect of electric information is acoustic.'[73] McLuhan's point holds even when information is perceived as an electronic image. This diagnosis, made in the age of live signal broadcast media, is still true for communication in online worlds, with a notable difference: the nature of signal transmission has dramatically changed from live transmission to ultra-short intermediary data storage in transmission. Furthermore, this archiving of presence introduces a traumatic irritation of the metaphysical notion of presence as such.

Today, what McLuhan's understood as 'acoustic space' – electricity-induced synchronicity – is replaced in internet communication culture

by radically asynchronous, non-linear, discrete temporalities. Instead of a homogeneous 'noosphere' (in the sense of Teilhard de Chardin), there are discontinuous rhythms; beats rather than waves. The familiar 'flow' of time is being replaced by calculated, 'clocked', mathematical time. The internet as the 'world' of today is based on *lógos* more than ever – on ultra-technical ratios, mathematical intelligence, operative algorithms and alphanumeric code. But this is a temporalized, dynamic *lógos* performed by postings and repeated status updates. This techno-logical mechanism is rooted in rhythms and delays, short-time storage and dynamic processing and is thus sonic by its very nature. The term *sonic* here refers to a specific coupling of acoustic tempor(e)alities with the practice of digital – that is, algorithmic – manipulation. In the world we currently experience as presence, there is an implosion of the transcendental reference 'time' into a chrono-poetic multiplicity of times and timings, such as clocking and data synchronization within computers.[74] The 'Time-To-Live' in internet data packet transmission determines the success of communication in virtual, calculated space in a radically time-critical way.[75] Sonicistic tempor(e)alities unfold even in the 'social web' with its data flows and rhythms: '[…] various techniques and technologies of time management […] is what characterizes the specificity of reproducing existing worlds in network culture.'[76]