AURALIZATION AS RE-ENACTMENT OF THE SONIC PAST

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Introduction

For centuries historical research has privileged the visible and readable archival records, thus fulfilling Marshall McLuhan's 1962 diagnosis of the *Gutenberg Galaxy* being dominated by visual knowledge.

But with auralization, a new kind of "virtual" (that is: numerical simulation-based) historical research has emerged: the research into past sonospheres and ways of listening long-time ago. Auralising makes random acoustic signals audible within a computer-modelled spatial surrounding.[1] This algorithmic tool has mostly been applied for the design of new, that is: *not yet existing* concert halls, or for the restauration of *still existing* halls. But in the interest of historical research even the acoustics of rooms which *exist no more* can be derived from auralization on the basis of computer-based simulation - with all the epistemological ambivalence of "(re-)construction".

Already with the arrival of the phonograph the question arose if soundscapes for the time previous to Edison can be reconstructed. With auralization, a new kind of "virtual" (that is: numerical, simulation-based) method has emerged: the research into past sonospheres and ways of listening long-time ago. An extended notion of sonic heritage emerges from auralisation as re-enactment of the sonic past and acoustic simulation as historical method.

Methods of exploring the sonosphere of ancient Greek theatres by application of mesuring technology have been developed long ago. In the meantime, audio communication has extended its research methods to re-enactments of ambisonics of the past - be it historic concert halls or other architectural spaces and even pre-historic landscapes. Thereby a veritable acoustic media-

1 As defined in Weinzierl 2002: 20

archaeology is emerging where the term "archaeology" is more than just a metaphor for digging for new records from the past. The paper discusses in case studies its technological means and the kind of new cultural knowledge which stems from that approach. Hermeneutic chances and limits of such re-auralization as new form of historical method and research are being discussed.

To what degree can auralization (sonic simulation based on measurement) provide a new kind of algorithmically synthesized record - and can this record still be called "historical"? Can the strict criteria of what is defined as historical record (German "Quelle") be applied to ephemeral settings like sonospheres? Here a double meaning of "record" is implied: the traditional textual document in symbolic (alphabetic) code, but recently signal recording of time-varying signals as well. There is a new possibility for tele-communicating with the past, embodied and transmitted in the acoustic records and channels.

As a result of media culture since nineteenth century, the traditional range of text-based, symbolic records of the past has been supplemented by auditive and visual signals. Acoustic signals are defined as time- and/or space-varying physical quantities. In the context of signal processing, not arbitrary on-off-signals but only (analog and digital) signals that are representations of analog physical quantities are considered as signals[2] - thus necessarily always being *embodied* in the material world which remains from the past. To what degree can such an ephemeral time-varying signal like sound be reconstructed? Sounds from the past are commonly associated with recording media like the Edison phonograph. In a more active sense, media-archaeology of past sonospheres implies the technologically active agency of reconstruction, with the measuring media and signal processing methods (impulse response) themselves being the active archaeologists.

Since Edison's phonography sound, noise and voices can be technically recorded and thus memorized, resulting self-expressively in extended possibilties of sonic heritage. Research into past ways of listening have emerged in Science & Technology Studies as a new branch of historical knowledge. Here, the term *sonic environment* is commonly associated with industrial and other sources of noise.[3] Complementary to the social *history* of such sonospheres there is a need for an *archaeology* of sonic expressions.

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2 Entry "Signal Processing", online http://en.wikipedia, accessed on 25 November 2010

3 See Karin Bijsterveld, Mechanical Sound. Technology, culture, and Public Problems of Noise in the Twentieth Century, Cambridge, Mass. / London (The MIT Press) 2008, 11f, referring to Murray R. Schafer, The Soundscape. Our Sonic Environment and the Tuning of the World, Rochester, Vt. (Destiny Books) 1994 [originally 1977]

By auralization as re-enactment of the sonic past, the historical method is not only extended but even pushed to its margins, since the temporal affect which arises from such media-archaeological auralization as "re-presencing"[4] is different from the familiar text- or image-based historical sensations. Historical argumentation as a cognitive operation of organizing past data will never be audible but only readable in complex textual argumentation; the historical method, though, will certainly be extended to sonic articulation as well - pushing the notion of history to its margins.

To what extent is the auralization of past sonospheres a valid historical or an archaeological method of research?

In its widest sense everything counts as historical source from which knowledge about the cultural past can be derived - be it texts, objects or settings. The discipline of history treats the past as a sender system whose receiver are the present historians themselves - a telecommunicative dispositive. Johann Gustav Droysen who in his *Historik* once differentiated between records from the past which were intentionally constructed for tradition ("Quellen") and unintended records as remnants ("Überreste"). When an old building as a piece of the past is still in use, it turns out "historical" only when being perceived as such by research.[5]

More recently Michel Foucault criticized the discipline of history for turning *monuments* of the past into *documents* to be memorized, even if they are often of non-linguistic nature and of different enunciative qualities.[6] He rather proposes to investigate remnants from the past by reconfiguring them into new elements - elements whose smallest units nowadays are *binary digits*. Even if acoustic spaces which derive from previous times are algorithmically re-sonified, they remain silent in the Foucauldean archaeological sense.

Mesaurement and simulation as two modes of auralization of past, therefore silent sonospheres are not historical methods *per se* but rather what historians call "auxiliary sciences" to the discipline of history (*Hilfswissenschaften*, in German).

The British historian R. G. Collingwood subsumed source-critical history under the general name of "archaeology" for which he lists

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

5 Johann Gustav Droysen, Historik, edited by Rudolf Hübner, Munch / Berlin (Oldenbourg) 1937, 37

6 See the Introduction to his *Archeology of Knowledge*, xxx

"departmental sciences such as palaeography, numismatics, epigraphy, and so forth."[7] The ambition of the present paper is to add auralization to this list. "These archaeological sciences are a *sine qua non* of critical history. They are not themselves history; they are only methods of dealing with the soures of history" <ibid.>. "They form, as it were, the bones of all historical thinking."[8]

In its narrative discursive form, "[H]istory itself must be flexible, but it must have rigid bones [...]. [...] the concreteness of history can only be reached through the abstractness of the archaeological sciences."[9] Collingwood in fact describes the archaeological method in terms which can be applied to auralization as well: "The archaeologist feeling his way towards new advances is constantly asking himself whether this or that detail [...] can be proved characteristic of a certain date or a certain origin [...]."[10]

But without historical imagination (usually supplied by philosophy of literature), inquiries into the past remain poor, Collingwood insists. Inbetween now a rule-governed kind of scientifically controlled imagination has emerged: digital simulation and modelling.

The *unprocessed data* provide the archaeological material upon which historiography might be based: "As historical evidence, records are largely unconscious, and not slanted for the consumption of posterity. In this they are therefore akin to the vast majority of archaeological artifacts".[11] At that point, algorithic data processing comes in - the computer as active media-archaeologist.

<neu 5/2014> Auralization method has been proved to be capable of reproducing prediced room acoustical properties: "When listening to the auralization and comparing to dummy head recordings in the same position in the same room, the differences are hardly audible. The auralization technique has matured to such a level, that the human ear can hardly tell wheter it is a simulation or not."[12] From that an ambiguity of a different kind arises: Uncertainty in human judgement about the validity of an acoustic

7 "Outlines of a Philosophy of History" (manuscript 1928), in: Collingwood 1946/1993: 426-496 (490)
8 Collingwood 1946/1993: 491
9 Collingwood 1946/1993: 491
10 Collingwood 1946/1993: 491
11 D. P. Dymond, Archaeology and History. A plea for reconciliation, London (Thames & Hudson) 1974, 67
12 Jens Holger Rindel / Claus Lynge Christensen, Room acoustical simulation and auralization. How close can we get to the real room?, keynote lecture at WESPAC 8 (The Eighth Western Pacific Acoustics Conference), Melburne, 7-9 April 2003, Manuscript No. 1025J, chap. "Conclusions". On the *approximative* reliability of room-acoustical simulations, see as well Weinzierl 2002: 143 f.

record concerning a "historical" room. If echoes and reverberations are simulated correctly, "the auralizations from simiulations actually sound more natural than the auralizations using the measurements the real room"[13]. Such hyperreal (in Jean Baudrillard's sense) *Verunsicherung* is well known from an ancient sonospheric setting itself as descibred in Homer's *Odyssee* - the acoustemic challenge embedded in the Sirens' song with its turning the notion of human singing upside down: "Some have said that is was an inhuman song - a natural sound (is there such a think as an unnatural sound?) but on the borderline of nature, at any rate foreign to man; almost inaudible [...]. Others suggested that it [...] simply imitated the song of a normal human being, but since the Sirens, even if they sang like human beings, were only beasts [...], their song was so unearthly that it forced those who heard it to realise the inhumanness of all human singing."[14]

Here, a methodological provocation emerges. Acousticians have a different judgement of the validity of aural simulation than historians. When soundscapes of the past ("auditory cultures") are being reconstructed by historical research, they become nothing more or less than an extension of the historical method - a new "auxiliary science" for historians. Soundscapes of the past are thus integrated (if not subjected) to the discourse of historiography - with terms like "history of sensory perception" (claimed e. g. by Karl Marx and Walter Benjamin).

While the discourse of history as cognitive dimension is bound to writing acts (or oral narrative), auditive evidence (as archived in the past) asks for an alternative approach: media-archaeological re-enactment, leading to a different temporal regime of auditory memory. Media archaeology, which is media studies as exact science, analyses media-induced phenomena on the level of their actual appearance, that is: enunciations in Foucault's terms. In our context this is physically real (in the sense of indexial) traces of past articulation, sonic signals which differ from indirect, arbitrary evidence symbolically expressed in literature and musical notation.

Knowing past sonospheres before Edison

The traditional *a priori* of the Humanities has been extended by signal-recording and signal-processing media which preserve and transmit what has previously been unaccessible to experience and thereby to understanding in historiography and as history. A different reality of the past is memorized by media which can register more than simply what only exists in writing or in narration - such as the noise of the battles and the sonic effects

13 Rindel / Christensen 2003, chap. "Subjective Verification"
14 Maurice Blanchot, The Sirens's Song. Selected Essays, Bloomington (Indiana University Press) 1982, 59-65 (59)

of artillery.[15] The Phonograph (respectively Emil Berliner's gramophone) registers the whole range of acoustic events.

In his novel dating from 1880, *L'Eve Future*, Vielliers de l'Isle-Adam lets the inventor of the phonograph, Thomas Alva Edison, lament on the loss of sonic information which has been lost in world history as long as this cultural memory was indeed reduced to what could historiographically be written down by the alphabet alone: "Voici tantôt soixante-douze siècles [...] qui, d'ailleurs, à titre de précédent immémorial, controuvée ou non, eût échappé à toute phonographie" <1880/1979: 34>.

Technical repeatability of recorded sound leads to the option of an almost a-historical sonic re-enactment of the past. But this "archival" approach comes to its limits when research is interested in sonospheres which have never been intentionally be recorded at all such as the acoustics of concert halls from long time ago. At that point, auditory evidence splits into physical and historical. The experimental approach to the reconstruction of auditory perception in the past is a method familiar from sciences: to *actually re-enact* the sound-generating setting. When we pull the string on a monochord in its subsequent intervals we actually experience the technical dispositive which has been the Pythagorean basis for musing about music and mathematis in the past - invariant towards entropic, historical time.[16] In fact, the vibration of the string short-circuits us with that past, undercutting the "historical" divide inbetween.

Delayed presence: Micro-tuning of space and time-reversal in acoustics

"Time machines" are frequently associated with movie-like time travelling such as in H. G. Wells' novel. But it is rather sound and music which allow for the most flexible and dynamic time travelling: a kind of uchronia rther than utopia.

Musical performance is a time machine indeed which on the basic level allows for time axis manipulation on the time-critical micro-level like electroacoustic delay lines or electromagnetic tape delay in early electronic music studios for phase shifting

15 See Bernhard Siegert, Das Leben zählt nicht. Natur- und Geisteswissenschaften bei Dilthey aus mediengschichtlicher Sicht, in: Claus Pias (ed.), Medien. Dreizehn Vorträge zur Medienkultur, Weimar 1999, 161-182 (175)

16 "Zeitinvariant sind Systeme dann, wenn sie zu unterschiedlichen Zeiten gleich reagieren, d. h. wenn eine Zeitverschiebung am Eingang ein zeitverschobenes, ansonsten aber unverändertes Signal am Ausgang produziert." Stefan Weinzierl, Grundlagen, in: same author (ed.), Handbuch der Audiotechnik, Heidelberg (Springer) 2008, 1-40 (15)

and superposition of sound events.

From the microsonic field of samples up to the macrosonic domain of a muscial composition, sound can be sculpted in time.[17] Jacob Kirkegaard's audio-visual installation *AION* acoustically unfolded the abondoned space inside the forbidden zone of the collapsed nucelar plant of Chernobyl in the Ukraine.[18] In each of the abandoned rooms, Kirkegaard made a recording of 10 minutes which he played back into the same room, then recorded this again - to be repeated up to ten times. As the layers got denser, each room slowly began to unfold *a drone* with various overtones.

In architecture, this corresponds with reverberative time: the audio signal delay known as "echo". In the case of ancient and medieval churches, "there is no mention of *intentionally* creating reverberation for its theological relevance"[19]; long reverberation as created in huge cathedrals does not as such correspond with the Pythagorean epistemology of harmony based on integer numbers which are infinitesimally broken by acoustic delay time. Such cathedrals - when still existing - are rather involuntary memories of past soundscapes, thus being time machines.

Space therefore can be explored by time-critical sound operations; the engineering of room acoustics by measuring operations such as pulse-response (developed by Walter Sabine around 1900) has even been extended to auralization as re-enactment of the sonic past.[20] Architecture is not just an empty vessel to be filled by arbitrary acoustics; the sound is rather been actively processed by the architecturally defined space itself. Spatial extension thus turns out to be the medium of temporal delay, while at the same time space itself becomes a function of temporal measuring. But it takes the memory capacity of an electronic device and its computational processing to provide fugitive sound articulation with a recurrent index of temporal depth - a sonic phenomenon of immediately passed / past tempor(e)ality.

Audio and vision belong to seperate spatio-temporal worlds; bringing them together is not possible without doing violence to

17 Steve Goodman, Timeline (sonic), in: Matthew Fuller (ed.), Software Studies. A Lexicon, Cambridge, Mass. / London (MIT Press) 2008, 256-259 (256)

18 DVD, created for his MA degree at the Academy of Media Arts, Cologne, January 2006; see http://fonik.dk/works/aion.html. Kirkegaard's sonic time layering explicitely refers back to Alvin Lucier's installation *I am sitting in a Room* (1969) where the technical set-up created a tempor(e)ality of its own.

19 Barry Blesser / Linda-Ruth Salter, Ancient Acoustic Spaces, in: The Sound Studies Reader, edited by Jonathan Sterne, London / New York (Routledge) 2012, 186-196 (195)

20 For an exemplary study see Stefan Weinzierl, Beethovens Konzerträume. Raumakustik und symphonische Aufführungspraxis an der Schwelle zum modernen Konzertwesen, Frankfurt/M. (Erwin Bochinsky) 2002

their tempor(e)alities.[21] The hearing apparatus is much more sensitive to micro-time-critical processes than the eye. While the flickering of an electric bulb (50 times/sec.) can not be noticed by the after-image in the eye any more (the cinematographical effect), the rising of acoustic pitch from 50 to 100 oscillations/sec. are very well perceived indeed. "History" commonly refers to emphatic, narrative time scales. But there is a micro-history in every sonic event which is a time-signal by definition.[22]

There is a difference between time-based concepts like "cultural history" and time-critical micro-histories based on time signals - smallest run time differences (intervals) between direct sound waves and reflected sound waves in terms of Dt as remarked by Aristotle in his treatise *On perception* as *to metaxy*.[23] Acoustic signal delay makes "the inbetween", in fact: the *medium* channel sonically opaque. Theater architecture, in terms of its time-critical acoustical feature, becomes "media theatre" in its truest sense: *to metaxy* as run time difference. Binaural acoustics turns out as implicit time-measuring instrument

This difference (not remarked as long as the reflection is so fast in small distance that it is for human ears indistinguishable from the original direct *schall*) amounts to perceptible (and in terms of music halls and audio technology even disturbing) echo effects as soon as the distance amounts to perceptible wave propagation (ca. 330 meters / sec. for sound waves in the air - depending on temperature).

It is by such time-critical measuring methods (impulse response as tool for the analysis of room-acoustics) that spatial models can be constructed, such as with the simulation software EASE. If the acoustic beam is micro-chronologically traced back to locate a listener position, micro-historiography is at work. Spatial order is thereby reconstructed from time-critical pattern.

Recorded sound is temporarily suspended from fading out and thereby becomes time-shiftable in replay, thus escaping historical time. Sonic events evolving in time might even be time-reversed by immediately sending them back to the source, as long as they propagates without losing too much energy to heat consisting of the random motion of individual air molecules instead of their collective movement in the sound wave.[24]

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21 As has been analyzed by Michel Chion, Audio-Vision. Sound on Screen, Columbia UP 1994

22 See section "4.1 Temporal structure of the sound field " in Weinzierl et al. 2014

23 See Aristoteles, Über die Wahrnehmung und die Gegenstände der Wahrnehmung, in: same author, Kleine naturwissenschaftliche Schriften (Parva Naturalia), Stuttgart (Reclam) 1997, 47-86 (76, § 446b)

24 Mathias Fink, Time-reversed acoustics, in: Scientific American, November 1999, 91-97 (92)

More than just a metaphor: Acoustic archaeology

Let us differentiate between the socio-cultural respectively "collective" (Maurice Halbwachs) memory of sonic events (auditory memory) and the actual (media) recording, measuring and simulation of sonic articulation from the past.

In the research group around the journal *Explorations* and especially in the *Culture and Communication* seminar at the University of Toronto the psychologist Carl Williams borrowed from E. A. Bott the notion of *auditory space*. The phrase was not only metaphorically electrifying, but Marshall changed it to "acoustic space" as the quality of electronic communication spheres.[25]

For an archaeology of the acoustic in cultural memory the human auditory sense does not suffice. Let us, therefore, track the sonic trace with genuine tools of media studies which is technical media themselves. One way of "acoustic archaeology" is to play a musical partition on historic instruments. But the real archaeologists in media archaeology are the media themselves - not mass media (the media of representation), but measuring media which are techically able to decipher physical signals, and representing them in graphic forms alternative to alphabetic writing since sound is articulation in time: the oscilloscope, or by numerical auralization.

Traditional archaeology - associated with digging artefacts from the past in sand and earth - is performed by humans. Let us rather focus on technologies themselves as new kind of archaeologists of acoustic and sonic phenomena. Electronic autopoiesis here becomes an argument: What has been electro-acoustically created, can be re-created by virtual archaeology, such as the *Virtual electronic poem* (an audiovisual 3-D projection) reconstructing Edgar Varèse's *poème électronique* installed once at the Brussels World Fair 1958 in the afterwards deconstructed pavillion designed by Le Corbusier and Xenakis.[26]

The immersive environment developed in The Virtual Electronic Poem makes the remarkable aspects of the Poème experience accessible again half a century after the event, thereby phenomenologically annihilating the difference in terms of time; the "historical" distance at least becomes mssively condensed. When it comes to recorded signals instead of printed alphabetic records from the past, re-play becomes possible by techno-mathematical means. What historical research demands here is a differentiation between

25 See Michael Darroch, Bridging Urban and Media Studies: Jaqueline Tyrwhitt and the *Eplorations* Group, 1951-1957, in: Canadian Journal of Communication, Bd. 33 (2008), 147-169 (156)

26 The *Virtual electronic poem* has been installed at Medienkunsthaus TESLA, Berlin, in January 2006

reproduction, simulation and emulation as known in retro-computing.

Let us separate mere functional emulation from simulation which includes the precise micro-temporal characteristics or the original as well - which is crucial when it comes to reconstruct past sonospheres. Lowenthal terms *emulations* as "respectful yet creative reworkings of earlier forms and styles [that] transcend mere copying" and views an emulation of past artefacts as an on-going and evolving acticity that is always of its time but yet an essential original feature persists in all the variations and derivatives. "A reincarnating simulation seeks to bridge the ever changing gulf between past and present [...]."[27]

Archaic sonospheres

Is there an option to catch the authentic visual of sonic gesture previous to the age of technical recording media, the phonograph, the Welte-Mignon recording piano, and cinematography? The historical performance practice (for dance, theatre and music) can not only be reconstructed by scriptural sources, or indirectly by re-using ancient hardware - be it historical architecture, or historical music instruments[28]. The sonosphere itself waits to be re-sonified by acoustic archaeology.

Archaeoacustics and sonic archaeology as ways of making acoustic properties of the cultural past "understandable" have been established as proper academic disciplines by now. Past sonospheres ask for a media archaeology of the acoustic - with digital media themselves being the active archaeologist. Digital Signal Processing and computer-based tools like wave field synthesis (which media-archaeologically recaptures Christiaan Huyghens's approach to the nature of sound propagation) and other technical dispositives now allow for the virtual (which is: digitally computed) reconstruction of "historic" acoustic spaces.

One can only tentatively re-create the soundscape of past cities like Berlin around 1900. But by measuring remaining rooms by acoustic beams[29], one can digitally *render back* the acoustics of

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27 Martin Campbell-Kelly, Past into Present: The EDSAC Simulator", in: Raúl Rojas / Ulf Hashagen (ed.), The First Computers. History and Architecture, Cambridge, Mass./ London (MIT Press) 2000, xxx-xxx (399), referring to: David Lowenthal, The past is a foreign country, Cambridge U.P. 1985, 301 <prüfen>

28 See Peter Donhauser, Elektrische Klangmaschinen. Die Pionierzeit in Deutschland und Österreich, Wien - Köln - Weimar (Böhlau) 2007

29 See the media art work *Echo Rotation* by Robert Schwarz and Emad Parandian, exposed at the Ars Electronica festival in Linz, Austria, September 2009

architectural spaces such as ancient Greek theatres.[30] Even if our present ears may have been *tuned* differently since, there is a acoustic tempor(e)alty which *endures* in Henri Bergson's sense. Once technically recorded, sound is eqipped with an "historical index" (Walter Benjamin's term) which transcends the purely historicist chronology. The positivist illusion of simulating past acoustic space is deferred by the more difficult task of reconstructing acoustic time: time-tuned sound. Such a sonosphere refers a) to the surrounding space and b) to the sources of sound, f. e. early music instruments.

Case study I: Sirenic voices

Auralization makes implicit, latent sonic situations explicit, that is: accessible for human hearing. This method becomes a tool, an auxiliary science (German "Hilfswissenschaft") for exploring a new kind of sources (rather than "evidence" which is a visual term) in historical research. Not only room acoustics in closed spaces but past sonospheres thereby become accessible again. Different from textual literary records which do not allow for an experimental reconstruction of the author's original mind-setting, archeoacoustics places the "observer" in a co-original listening situation.

Facing the Amalfi coast south of Naples, the Li Galli islands (Gallo Lungo, Castelluccio and La Rotonda) have been known since antiquity as home of the Sirens. The media-archaeological question is this: It there something like a physically given setting, a grounding in the "real" of signal processing, that kept cultural memory insisting on that place?

According to Homer, Ulysses could hear the Siren song just because a divine power (a *daimon*) calmed down the sea around the Siren islands to get a perfect signal-to-noise ratio. If there were waves, they were silent like ultra-sonic radio frequencies to not resonate in human ears unless a radio receiver demodulates them down to low-frequency loudspeaker emission.

While being addressed by the Sirens' singing, Ulysses is not only in a boat *on* the sea but *in* the waves. The human ear perceives kinetic impulses (the acoustic waves) rather affectively than consciously.[31] The optical regime is about immediate impressions while keeping physical distance; sound in a different haptic way directely attacks the body. With the absence of ear-lids, there is almost no escape to the acoustic attack once the visitor enters a sonosphere. This sonic imprisonment takes place on two levels: the

30 On the "musical" tuning of ancient Greek theatre architecture, see François Canac, L'acoustique des théâtres antiques, Paris (Centre national de la recherche scientifique) 1967

31 See Victor Zuckerkandl, Sound and Symbol. Music and the External World, Princeton (Princeton UP) 1956, 204f

manifest level when we listen to an acoustic composition, and the latent level when even what we see as optical event turns out to be a secondary function of sonic eventality - such as the ultrasonic or the fully-electronic image.

All of the sudden, research on sonicity takes place in the whole spectrum between mythology and media archaeology, between human voice and electronically produced frequencies.

A media-archaeological research expedition by members of Humboldt University Berlin (assisted by the Center for Media Arts and Technology Karlsruhe) in early April 2004 experimented with sound propagation at the supposed original place of the Sirens' singing, the Galli Islands. Both synthetic signals (sine tones, white noise) and natural voices (vocalizations of Monk seals, voices of two female singers) were broadcasted *via* loudspeaker. The signals were then recorded along a supposed line along which Ulysses might have approached the Siren Island. The acoustic analysis of the recordings revealed an acoustic effect which tentatively explains the nature of the Sirens myth: The specific position of the islands (two rock formations opposed to a large curved island) results in a deformation of emitted vocal signals by amplification and changes in the timbre.

Fig.: "Spectrogramm of a vocal sung by two female sopranos exploring the Sirens' songs in the midst of the Li Galli islands"[32]

But to what degree is this acoustic latency (as revealed by media-archaeological research) evidence for a conscious use of such reverberations in ancient times?[33] The correlation between this acoustic latency as revealed by cold measuring evidence with a conscious use of such reverberations in ancient times induced by the semantically heated transmission of the Siren songs in the vocal alphabet strikes the central question of cultural tradition when conceived in techno-mathematical terms of communication theory. Any such deduction of sonic significance from archeoacoustics oscillates between signal or noise.[34] What remains undecidable is the degree to which a conscious use of resonance in ancient times has been applied to such acoustic settings. But the key hypothesis based on such findings is that the data won by acoustic

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32 From: Karl-Heinz Frommolt / Martin Carlé, Der Gesang der Sirenen. Homers Dichtung und akustische Realität, in: Hugo Fastl / Markus Fruhmann (ed.), Fortschritte der Akustik. Plenarvorträge und Fachbeiträge der 31. Deutschen Jahrestagung für Akustik DAGA 2005 in München, Berlin (DEGA), vol II, 797

33 See C. Scarre / G. Lawson (eds), Archaeoacustics, 2006

34 The borderline between culturally intended sound and implicit acoustic settings separates "prehistoric" sonic articulation from its cultural history not only in a temporal but in a structual sense. See Chris Scarre / Graeme Lawson (eds.), Archaeoacustics, Cambridge et al. (McDonald Institute for Archaeological Research) 2006

measurement correlate with essential assumptions in ancient Greek musical theory and enharmonics. The clue to the location of the Siren songs might therefore be that the sonosphere specifically struck the Greek ear which was tuned by its culture of musical listening. Unexpectedly, this "musical" conclusion coincides with the results of auralizing the acoustics of Renaissance theatres in Italy.

Case study II: Auralization of *Teatro Olimpico*, Vincenza

A test case for the epistemological gap which occurs between discovering the sonic dimension as new kind of historical source and its simulation is the reconstruction of the acoustic condition of Italian Renaissance theatres by auralization. This form of audio communication with the architectual past is no understanding in the hermeneutic sense, but first of all a co-original reset.

The Teatro Olimpico in Vicenza (opened in 1585) is preserved until today (even if not in the original condition) and are thus radically present (enduring) in terms of architecture to the contemporary spectator and listener. Still it is characterized by what by definition constitutes the past as archaeological site: the absence of humans - the audience which once filled the theatre in its performative meaning. The sonic retro-projection of listening subjects (receiver positions) based on impulse response measurements appropriate for auralization therefore is an additional virtual information. "Only an acoustical reconstruction of the historical conditions including the effect of the audience would give reliable evidence of the original performance conditions" <Weinzierl et al. 2014>. Acoustic information derived by measurement is archaeological evidence, but only by subsequent simulation of the occupied state this information turns into a "historical" one. If such auralization is computationally folded upon a reconstruction of the original theatre which itself is a computer model, a new kind of historical imagination emerges which transcends its data-archaeological source base. The epistemologically critical qualitative jump occurs exactly between the measurement of physically given spaces and the simulation of virtual sonospheres. Reverberation times for the unoccupied case of the theatres under analysis are derived from the measurement, while impressions for the occupied case are derived from the non-human, software-based simulation of human presence. Here, the differences between measuring of real conditions and simulations oscillate: empty room *versus* occupied condition (including a partial reconstructin of the historical state).

Different from historical imagination which tends to fill the lacunae in the archived sources, a disciplinary virtue of archaeology is the transparency of uncertainties. An impulse response in the *Teatro Olimpico* for a central source and receiver

position can be reproduced, but the simulation reaches its limits when it comes to correctly reproduce a cluster of simultaneously arriving reflections from complexly structured surfaces which in fact make the "historical" identity of the concrete room - the individual material fingerprint.

The Teatro Olimpico integrates elements known from Roman theatre design into a large and reverberant enclosed space. From the room acoustical measurements according to ISO 3382 a remarkable conclusion can be derived:

"With reverberation times of more than two seconds and speech transmission indices (STI) close to 0.5 even for the occupied condition, modern standards of theatre acoustics with their predominant focus on speech intelligiblity seem inappropriate for buildings of this period. Their acoustical properties along with their reception as documented by historical sources, instead, strongly supports the notion that theatres of the 16th and early 17th century have to be equally, if not primarily, considered as musical performance spaces. They represent the Renaissance concept of a theatre of antiquity to be reborn in buildings based on antiquity, and anticipate elements of the new genre of the opera emerging at the same historical point in time."[35]

The stratetic link between the auralization of the Palladio theatre in Vincenza and sonic media archaeology is in its "musical" conclusion: The mesaurements revealed the prevailance of the musical performance part in such Renaissance auditories which were closer to the ancient concept of the theatrical choir (and Monteverdi's early forms of opera) than to the speech-focused modern theatre.

In terms of speech transmission, the Vincenza theatre - concluding from the measurement results - seems deficient: "one could be tempted to consider the buildings as an acoustical failure, potentially due to a lack of experience in theatre design or a lack of room acoustical knowledge in general. This conclusion would, however, not take account of the cultural context." <Weinzierl et al. 2014>. This coupling of measurement data and its derivative simulation with the textual archive turns media-archaeological research into an historical argument. Respecting the numerous preserved reactions to the opening performance of *Edipo tiranno* in the Teatro Olimpico, all sources underline the positive overall impression of the performance space properties. "They also give evidence of the importance of the musical part of the theatrical performance" <Weinzierl et al. 2014> and its acousmatic effects, since the instrumental effects turned out from behind the stage. Whereas the the choir was acting on stage, the musical instruments were not located in the orchestra space in

35 Stefan Weinzierl, Paolo Sanvito, Frank Schultz and Clemens Büttner, The acoustics of Renaissance theatres in Italy, forthcoming in: Acta Acustica united with Acustica 2014 (Summary)

front of the stage, but inside the backstage scenery, providing for a soft and gentle sound. With respect to the instrumental parts, Angelo Ingegneri, stage director of the opening performance, reports that after the curtain had fallen to the ground in front of the stage, an instrumental and vocal music, the sweetest one may imagine, and at the same time equally soft, would begin to resonate from behind the stage. It appeared as if it would resonate "from far away".[36]

Here the new quality of supporting evidence prodvided by historical records is revealed by auralization - a research method which differs from the traditional text- or score-based archive: "The duration of the purely instrumental parts is unknown, since no score is preserved" <Weinzierl et al. 2014>.

Since the Teatro Olimpico stands for the idea of an ancient theatre to be literally reborn, the musical composition, with its predominant focus on text intellegibility and a subordination of instrumental parts, anticipates elements of the opera which emerged only a few years after the opening of the Olimpico such as known from Monteverdi. "That the Teatro Olimpico provided appropriate acoustical conditions for this new theatrical genre seems clearly confirmed both by contemporary reports and by the acoustical data of the current investigation" <Weinzierl et al. 2014> - thus mirroring re-enactment idea of "Renaissance" both in the macro-temporal (cultural history) and micro-temporal (auralizating) sense, short-cutting the "historical" distance.

Operative aurealization is able to "tunnel" the temporal difference which separates the present observer from the situation in the Renaissance past; a temporal *momentum* flashes which can not be grasped by macro-temporal concepts like "history" or sociological terms like "collective memory" any more, but rather constitutes a short-cut between present and past - a *resonating intervall* in terms of McLuhan who got this expression from Werner Heisenberg's quantum mechanics.[37] Computer-based acoustic modelling here acts as virtual archaeology, allowing for an acoustic time travelling. Next to simulating life and physics in laboratories as practiced in ninetheenth century science, the experimentalisation of the sonic past emerges.[38] This is my now means a metaphysical assumption, but based on the most physical techno-mathematical

36 As quoted <???> in: A. F. Gallo: La prima rappresentazione al Teatro Olimpico: con i progetti e le relazioni dei contemporanei. Edizioni Il Polifilo, Milan, 1973. See A. Ingegneri: Della poesia rappresentativa e del modo di rappresentare le favole sceniche. Ferrara: Baldini, 1598

37 See Marshall McLuhan / Bruce R. Powers, The Global Village. Transformations in World Life and Media in the 21st Century, Oxford et al. (Oxford University Press) 1989

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

computation.

"Re-enactment" of past sonospheres (Collingwood)

The "musical" conclusion of both case studies in the exploration of past sonospheres leads to a final re-entry of the discussion of such operations for historical sources. Even for the most critical historian, musical temporality is of a specific nature which requires precise reconstruction of historical contexts but at the same time transcends the supposed historical distance which separates the present from the Renaissance past, as expressed in R. G. Collingwood's methodological *Idea of History*: "re-enactment". The sonic sphere allows for a temporal time-tunneling in a special way since it consists of time matter itself.

The rehearsal of a musical piece from the past transcends its unique location in time (what Walter Benjamin called "historical index"). Collingwood's notorious claim that historians have to "re-enact" the past event partly derives from his astonishment that a present performance of a musical piece composed at some earlier time can still be understood at all. This requires that the auditor performs it again in imagination.[39] Different from historical imagination in its literal visual sense, "the *sine qua non* of writing the history of past music is to have this past music *re-enacted in the present*"[40]. This practice of re-presencing (well known in its technological equivalent as hardware and software replication and emulation in Retro Computing culture today) escalated in audio recording media such as the phonograph. A gramophone disc, according to Günther Stern's (*alias* Günther Anders) habilitation thesis *The musical situation* (around 1930), does not reveal an acoustic image of the *Mondscheinsonate*, but the *Mondscheinsonate* itself[41] - just like the radio does not reproduce speech and music, but actually displays them (as argued by Theodor W. Adorno[42]). Auralization, in a further escalation of re-presencing the sonic past by algorithmic means, finally provides archival silence with sound.

Time-based signal processing media share with musical performances

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39 See William H. Dray, History as Re-Enactment: R. G. Collingwood's Idea of History, Oxford et al. (Oxford University Press) 1995

40 Collingwood's 1928 lecture "Outlines of a Philosophy of History", published in: R. G. Collingwood, The Idea of History [*1946], rev. ed. Oxford et al. (Oxford University Press) 1993, 441

41 As quoted in Reinhard Ellensohn, Der andere Anders. Günther Anders als Musikphilosoph, Frankfurt/M. (Peter Lang) 2008, 64

42 In: Theodor W. Adorno, Current of Music. Elements of a Radio Theory [1940], hg. v. Robert Hullot-Kentor, Frankfurt/M. (Suhrkamp) 2006

the power of generating the real-time affect of presence[43] - while at the same time undoing its transitive experience by the repeatability of any acoustic record. Sonic temporality thus turns into technical sonicity.

[Literature]

<...>

Stefan Weinzierl, Beethovens Konzerträume. Raumakustik und symphonische Aufführungspraxis an der Schwelle zum modernen Konzertwesen, Frankfurt/M. (Erwin Bochinsky Verlag) 2002

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43 See Hans Ulrich Gumbrecht, Production of Presence. What meaning Cannot Convey, Stanford, Calif. (Stanfort UP) 2004