Rotting Sounds

Artistic Research Practice in Experimental Sound Art

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The majority of today's media is produced in the digital domain. Although digital data are adorned by a myth of perfection, everyday experience does provide evidence for the existence of degradation and, ultimately, data loss in various forms. The multi-year artistic research project *Rotting Sounds* has investigated the causes, mechanisms, and effects of such deterioration, specifically in the context of digital audio. This report gives a condensed account of some of the theoretical foundations and methodical approaches chosen. The digital-analog interface, information encoding, as well as the *deep time* perspective are specifically highlighted. We present a number of artistic works that have been developed as experimental systems to co-generate questions and finally lead to various conclusions. These concern the controllability of such experiments and the interrelationships between (sound) information and its environment. The term of *digital patina* was introduced to characterize observed aesthetics in permanent transformation and to open up a new perspective on the existence of the digital in a material context.

Der überwiegende Anteil heutiger Medien wird in digitaler Form produziert. Digitale Daten sind von einem Mythos der Perfektion umrankt, obwohl die Alltagserfahrung Evidenz für die Existenz von Degradation und letztendlich Datenverlust in verschiedener Weise liefert. Das mehrjährige künstlerische Forschungsprojekt *Rotting Sounds* untersuchte die Ursachen, Mechanismen und Auswirkungen solcher Verfallserscheinungen, speziell im Kontext von digitalen Audiodaten. In diesem Bericht werden einige der gewählten theoretischen Grundlagen und methodischen Ansätze in komprimierter Form dargestellt. Besonders hervorgehoben werden die Digital-Analog-Schnittstelle, die Kodierung von Information, sowie die Perspektive der ›tiefen Zeit‹. Wir präsentieren eine Reihe von künstlerischen Arbeiten, die als experimentelle Systeme entwickelt wurden, um Fragen zu generieren und letztendlich zu verschiedenen Schlussfolgerungen zu gelangen. Diese betreffen die Kontrollierbarkeit solcher Experimente und Zusammenhänge zwischen (Klang-) Information und ihrer Umgebung. Der Begriff der ›digitalen Patina‹ wurde eingeführt, um beobachtete Ästhetiken in permanenter Transformation zu charakterisieren und eine neue Perspektive auf das Wesen des Digitalen im materiellen Kontext zu eröffnen.

SCHLAGWORTE/KEYWORDS: artistic research; deep time; degradation; digital media; digitale Medien; experimental music; experimentelle Musik; Klangkunst; Künstlerische Forschung; sound art; tiefe Zeit; Verfall

Introduction

"Pure, perfect sound – forever" was the marketing slogan used by Philips corporation to introduce the digital compact disc (CD) in the early 1980s. Almost forty years have passed since then and the vast majority of the media on offer, audio and video, is now produced and stored in digital form. In contrast to the marketing slogan, the fact that digitally stored information is affected by deterioration processes, has been most knowingly engineered into the data format of the compact disc and into the reading mechanism of players in the form of a multi-level error correction mechanism. These mechanisms are designed to counteract the effects of data corrosion on the physical information carriers. In close introspection, the error correction mechanisms wrestling with physical erosion are as much sound influencing processes as filtering or dynamic effects that have been applied to the music in a studio, only that they are beyond control of the original music

makers or publishers. The sonic results of such error-correcting audio processing are instead dependent on the individual path that the data carrier takes through time.

Since 2018, the artistic research project *Rotting Sounds*[1] has been investigating the fundaments, mechanisms, and effects of such phenomena of digital erosion, especially focusing on digital audio. In its course, artistic works such as compositions, sound installations, performances, sculptures, etc., have been created as experimental setups to reveal specific conceptual and aesthetic characteristics of degradation processes and thus – through thorough introspection – generate new knowledge within the field of experimental music and media.

The project is a cooperation among the *mdw – University of Music and Performing Arts Vienna*, *Department of Composition, Electroacoustics and Tonmeister Education* (represented by Thomas Grill), the *University of Applied Arts Vienna*, *Institute of Fine Arts and Media Art*, *Department of Art & Science* (Till Bovermann) and the *Academy of Fine Arts Vienna*, *Institute for Conservation – Restoration* (Almut Schilling) funded by the *Austrian Science Fund* (FWF) through its PEEK program.[2]

Although the compact disc does serve as a good example to illustrate some general ideas of the project because of its widespread use in the last decades, there are many other forms of digital audio representation, and consequently, other forms of digital erosion with respective aesthetic implications.

From the standpoint of artistic practice in digital sound, the main research objectives were given by the following original formulation: How can degradation effects be understood, actuated, reproduced, directed, and harnessed within the field of sound art?

In order to treat such a broad field, more detailed questions arose:

– What are the fundamental differences between digital and analog sound and how does this affect deterioration processes?
– What are established techniques to represent sound digitally and what are their respective properties regarding storage, archiving, and (contextual) development over time? Which techniques are conceivable, yet not established and why?
– Which mechanisms of deterioration take place in digital sound? What are their respective aesthetic qualities?

The comprehensively constructive approach, expressed by the subtitle "Embracing the Temporal Deterioration of Digital Audio," was captured into the form of a manifesto publication shortly after the project start.[3]

The structure of this report is as follows:

In the section following this introduction, we will give a terse description of the notion of "experimental systems" as we have understood and employed it in the *Rotting Sounds* context.

In order for the project to be properly rooted, we had to inspect the very fundaments of digital audio representation. This is delineated in the third section "The digital-analog interface: 1-bit audio," covering the boundary between the analog and the digital domains which is pierced by the "1-bit audio" format.

1 http://rottingsounds.org (30 Nov 2022).

2 https://www.fwf.ac.at/en/research-funding/fwf-programmes/peek(30 Nov 2022). The project was funded by the *Austrian Science Fund* as project AR 445-G24.

3 See Grill et al. 2018.

The fourth major section "Encoding/decoding" expands on the concept of the *codec* (short for *(en)coder-decoder*), that is, a protocol used to represent sound and music in the digital domain. Many different *codecs* exist and each one has distinct properties to be considered regarding the representation of sound, and specifically, in the context of erosion.

The fifth section "Deep time" examines the circumstances of (long) time spans as researched in the project. Although *Rotting Sounds* was designed to last four years – the maximum duration possible in the PEEK funding program – we have conceptually extrapolated the project's time horizon to speculate all the way into deep time.

These sections are illustrated by various "experimental systems" we have designed and realized throughout the artistic research project. These have been made both by artist-researchers directly associated with the project as well as by external artists commissioned to create original works related to the *Rotting Sounds* themes.

The final section concludes with insights based on the research project.

Experimental Systems

Within the *Rotting Sounds* project, experiments have not been established to prove specific theoretical considerations. This is typical for artistic research, where experimental arrangements can function as co-generators for questions *ab initio*. Following Hans-Jörg Rheinberger, experimental systems "are set up in order to give answers to questions that we are not yet able to formulate clearly. In a typical case, an experimental system is, in [François] Jacobs' words, a 'machine for making the future'."[4] For Rheinberger, it is obvious that such experimental systems do not directly guide reasoning, instead "[…] what is at issue is the exact opposite: a movement oriented through instrumental peripheral conditions in which reasoning is torn into the game of material entities."[5]

For our case of erosion processes, very literally, the material and peripheral conditions are the major determining factors. In a digital media environment, such material may be physical – data carriers for instance – or from the information domain.[6] Many of our experimental systems – mostly sounding installations, as detailed below – have been designed as long-running recurrent systems whose mode of operation is the ever-repeating inscription of the system's operation on its status, be it a physical or information configuration.

The temporal disposition of our installations, constituted naturally from their sounding nature and the evolving erosion processes, fulfils Rheinberger's postulation that "such an arrangement must […] be set up 'differentially'. If it is organised such that the production of differences itself becomes the organising principle of its reproduction, then one can say that it obeys the kind of subversive, displacing movement Jacques Derrida referred to as 'différance'. In this sense, differential reproduction lends science, or better, individual research systems, their own internal time."[7]

4 Rheinberger 2012, 92.

5 Ibid., 90.

6 "Material" in the information domain metaphorically refers to the substance one shapes: digital data in various encodings.

7 Rheinberger 2012, 95.

There is a notable connection within our theme to physics' second law of thermodynamics. The latter establishes the concept of entropy, whose increase can be described as a spreading of energy states from a well-defined configuration (i. e., a localization) to a dispersed one or, following the formulation of Arieh Ben-Naim, one of "missing information."[8] The relationship to the process of erosion is – also intuitively – obvious. The increase in entropy for closed systems is said to be "what distinguishes the past from the future, giving a direction to time."[9] The experimental systems under our consideration may be characterized as "sufficiently closed," as environmental parameters should be controlled, thus generating said "arrow of time." In this sense, erosion's constitutive configuration changes and time directionality nicely connect to Derrida's "différance" in its implied "espacement" (spacing) and "temporisation" (temporalization), the constitution of primordial spatiality and temporality.[10]

In practical terms, most physical research experiments (i. e., sound installations) were located at the *Auditorium of Rotting Sounds*,[11] an unrestored building on the main campus of *mdw – University of Music and Performing Arts Vienna*, which used to be an auditorium of the former *School for Veterinary Medicine*. See figure 1 for an overview of the installations located therein. Other experiments have also been run in the course of long-term exhibitions or in digital space on a dedicated computing device, the so-called *rotter*.

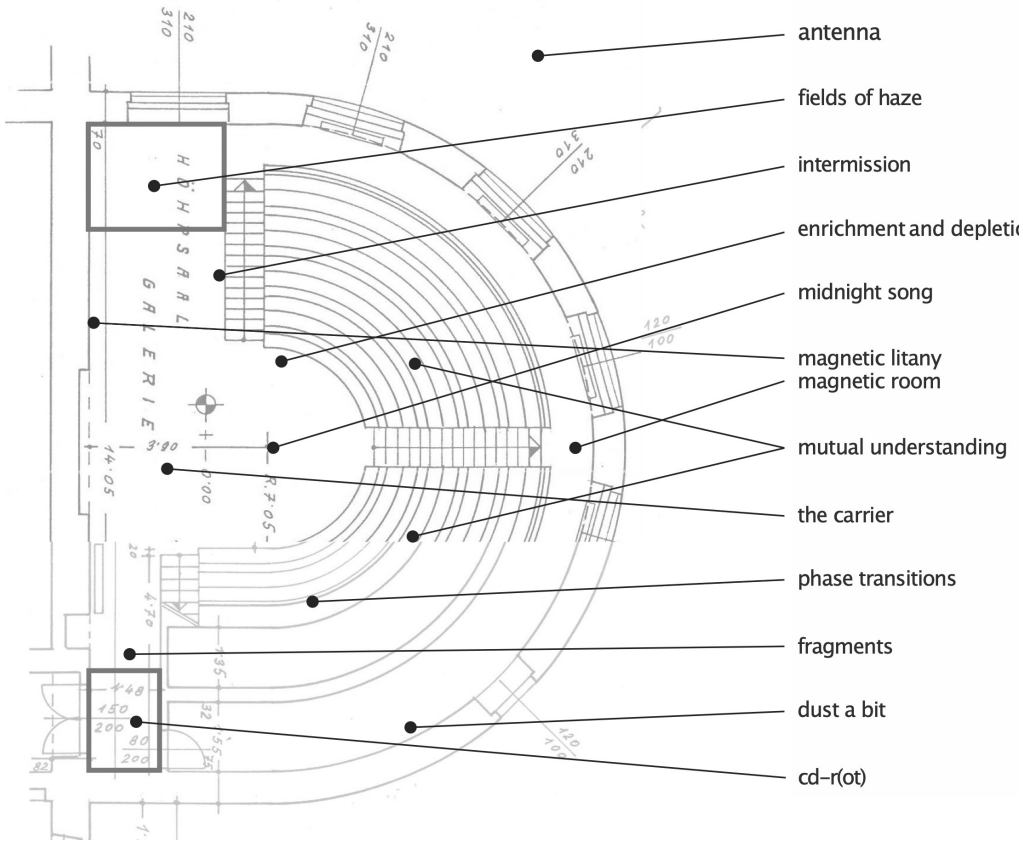

Figure 1: Floor plan of the *Auditorium of Rotting Sounds* with its experiments

8 Ben-Naim 2008, 19.

9 Hawking 2017, 149.

10 See Derrida 1982.

11 https://rottingsounds.org/auditorium (30 Nov 2022).

The Digital-Analog Interface: 1-Bit Audio

One radical approach we took within the scope of our project examines the rendering of sound as a 1-bit stream in which audio signals are represented as a pure sequence of binary states. Here, a signal is embedded in 1-bit noise with most of its frequency spectrum far above the range of human hearing. While the fundamentals of this encoding technique are well known, it became used commercially on a broader scale only in recent years. In our project, it turned out that 1-bit-based information representation techniques for audio were of particular interest in terms of digital deterioration research, primarily because the format can be played both digitally or using analog technology, thus entailing permeability of the border between digital and analog realms.

The non-auditory installation *Reference Tone*,[12] realized by Thomas Grill in 2020, makes a theme of this: a 1 kHz sine tone, as commonly used to calibrate equipment in the domain of audio technology, was printed in a spiral path (like a CD audio track) on a paper disc using 1-bit code. The object was placed on the floor of Vienna's *Museum of Applied Arts* (MAK) in a walk-through area for the duration of a month. While observation at a microscopic scale reveals a seemingly random noise pattern (see figure 2), the interference that arises from the track's spiral running in close proximity to itself reveals the periodic pattern of a sine wave when viewed from farther away. Although the "printed sound" is initially a near-perfect representation of the sine tone, the ongoing interaction with visitors lends it scratches and dents, giving it a specific patina that manifests itself as an erosion of the sonic representation: the "reference tone" is transformed in its own context.

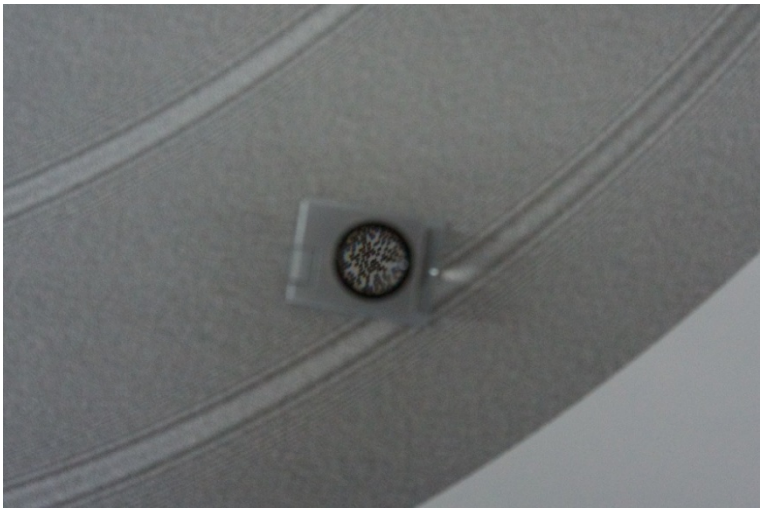

Figure 2: *Reference Tone* (2020), magnification of printed 1-bit audio data

Dust a bit,[13] designed and built by Klaus Filip and Thomas Grill in 2019, is an experimental system of the above mentioned recurrent type. A stationary musical chord in just intonation, represented as a 1-bit-audio signal with a sample rate around 1 MHz, serves as the starting material. The audio signal modulates the intensity of a laser beam. The laser light is sent through the auditorium, repeatedly deflected by mirrors, and is finally directed to a

12 https://rottingsounds.org/reference_tone (30 Nov 2022).

13 https://rottingsounds.org/dust-a-bit (30 Nov 2022).

phototransistor sensor. On its way through the space, the optical signal is disturbed by particles (i. e., dust) present in the air, causing the modification of individual bits of the 1-bit stream. After being registered by the sensor, the "dusty" bit stream replaces the original signal which is then sent out again through the laser into the room. This is repeated over hours, days and months and the erosion process can be followed via headphones and a live internet stream.

The installation has been restarted a couple of times because the carefully calibrated laser beam tends to wander out of focus over time. This is most probably due to temperature changes and/or vibrations in the building, causing the mirror arrangement to lose its precise adjustment. We have prepared timelapse recordings[14] of the sonic developments of the several installation runs – every time several weeks of collecting "dust." One minute of such a time lapse corresponds to a day of operation.

The software library *bitDSP*,[15] initiated and developed by Till Bovermann and Dario Sanfilippo,[16] started out as a set of functions for the audio-specific programming language *FAUST* and soon also encompassed derivative works based on it. While its functions are perfectly capable of being used in generative and representative contexts for 1-bit audio, their implementation was aimed towards exploration and research of the aesthetics underlying and emerging from bit-based algorithms and their deterioration. Functions range from simple bit operations over classic delta-sigma modulations to more experimental approaches like bit-based cellular automata, recursive Boolean networks, and linear feedback shift registers.[17]

The library was used in several performance settings, most prominently in a performance *Merge and Dissolve* (see figure 3) at the *Ars Electronica* 2020 and in a performance by Till Bovermann, Dario Sanfilippo, Martin Howse, and Kathrin Hunze for the *Rotting Sounds* symposium in 2021.[18]

Encoding/Decoding

Sound and thus music is ephemeral. It is carried from its source to our ears (and body) by means of pressure waves in air. To conserve it means to create some kind of description. For centuries, such descriptions were of a merely symbolic nature: musical scores serve as hints to musicians on how to use their voice or play their instruments in order to recreate the envisioned music. The introduction of the phonograph and later magnetic tape made it possible to capture sound and music in a less abstract form. The pressure wave in the air, i. e., its signal, was represented directly in height variations of a groove (phonograph), and respective variations in magnetic polarity (tape). In each of these cases, however, an (implicit) agreement is assumed about how to convert this description of sound into actual sound. While these early *codecs* were either self-explanatory or built directly into the (mechanical) playback devices themselves, the introduction of digital sound representations required a more explicit and machine interpretable instruction set

14 https://rottingsounds.org/2020/06/07/dust-a-bit-rec (30 Nov 2022).

15 https://github.com/rottingsounds/bitDSP-faust (30 Nov 2022).

16 See Bovermann/Sanfilippo 2020.

17 For information on these technologies, see the README document on the project website.

18 https://rottingsounds.org/symposium/ (30 Nov 2022).

in the form of algorithms. The aforementioned 1-bit representation of audio signals can be interpreted as a hybrid between analog and digital representation. However, many other forms of *codecs* are possible to define. Similar to the 1-bit *codec*, each of them holds a unique set of aesthetic deteriorative qualities – a topic that was persistently examined within the scope of the project.

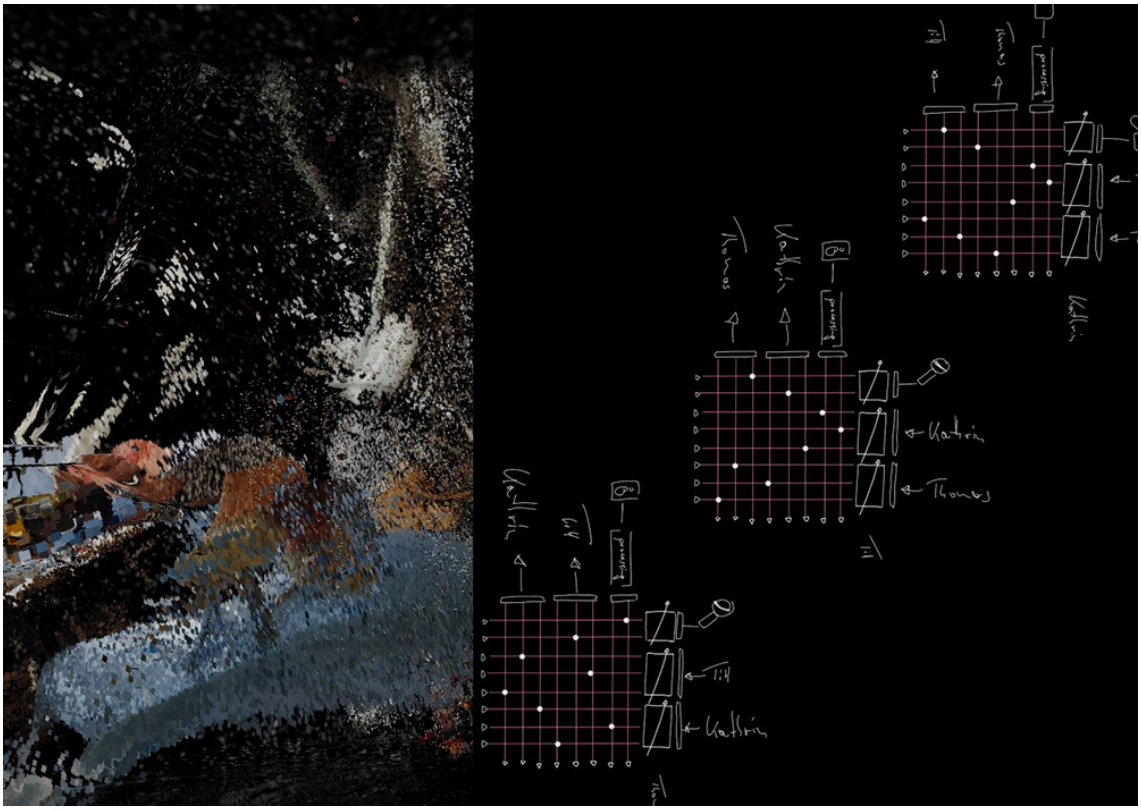

Figure 3: Live visualization still and score sketches for *Merge and Dissolve* at the *Ars Electronica* 2020

A widely established *codec* is based on Pulse Code Modulation (PCM), in which a time- and value-continuous analog signal is converted into a time- and value-discrete digital signal that can be transmitted and stored in binary form. The Compact Disc (CD) is a popular medium based on this *codec*. *CD-R(ot)*[19] by Almut Schilling and Till Bovermann investigates the deterioration processes originating from this commercial standard. A monolithic CD player stack (see figure 4) revealing the (im-)perfections of consumer digital audio was set up in 2019. Seven playback machines are fed with referential material, their analog output signal being identically and simultaneously amplified and emitted. Minimal differences of reproduction emerge, amplifying onto the false promise of "pure perfection" of the digital, the myth that 01010010111 are infinite integrity. Continuous playback causes degradation, amplified by controlled micro-manipulation of the CD material, triggering the very soul of digital reproduction: the error correction.

19 https://rottingsounds.org/threads/auditorium/cd-rot/ (30 Nov 2022).

Figure 4: *CD-R(ot)*

A different approach was taken with *CD manipulations (01)*,[20] a performative study by Till Bovermann in which error corrections and artifacts were provoked in CD players in the style of Nick Collins[21] by in vitro manipulation and interference with the CD and its player.

Resource constraints such as memory or bandwidth limitations require more compact and thus more complex *codecs*. MP3 is a common example for this. Its inception was motivated by demands in storing and transferring only those parts of a signal that are necessary to recreate a similar sound that cannot be distinguished from the original by the ear of an average mid-30s, white, human male working at or near the Fraunhofer institute in which it was developed. Workshops conducted within the scope of the project such as the masterclass at *Herzen University*, St. Petersburg[22] examined the deterioration of digital sound by use of MP3 artifacts.

Whilst the technological assumptions made for the MP3 algorithms are valid in their context of mass media, many other requirements for signal transmission or preservation can be imagined. Within our project this meant, e. g., to construct specific *codecs* based on artistic considerations, primarily focusing on the aesthetics of digital deterioration.

20 https://rottingsounds.org/2018/11/03/cd-manipulation-01/ (30 Nov 2022).

21 https://econtact.ca/20_3/collins_cdhacking.html (30 Nov 2022).

22 https://rottingsounds.org/2019/05/27/masterclass-herzen-2019 (30 Nov 2022).

The *Antenna*[23] installation, devised in 2019 by Juliana Herrero and Thomas Grill, creates an interface between sound and its environment. Like a telegraph, it transmits sounds generated from encoded text in the form of musical chords. The recited text originates from "The Art of Noises" (*L'arte dei Rumori*), a futurist manifesto written by Luigi Russolo in a 1913 letter to his friend and futurist composer Francesco Balilla Pratella.[24] The sonic vibrations are resonating through the filigree networked structure of the artwork, amplified and broadcasted into the surrounding air and modified by the environmental conditions – wind, rain, dust, birds sitting on the wire. At the other end of the wire network, the sounds are picked up again and translated back into text. This process can be followed on a small display. By the time, the environment of the sculpture inscribes itself into the text by disturbing single bits of the manifesto, slowly realizing Russolo's utopia by turning it from readable symbols into environmentally informed noise.

Over the course of the last decades, the traditional, symbolic form of music encoding, music engraving, has slowly and steadily converted to digital typesetting. In this representation, the musical information is subject to the very forms of temporal transformation researched in the *Rotting Sounds* project. As has been stressed above, the specific encoding of this digital data representation enables specific forms of erosion, which again give rise to likewise specific aesthetics of the musical outcome.

The composition *rill*[25] for ensemble by Adam McCartney and Thomas Grill, premiered at the *Wien Modern* festival 2021, addresses such processes of binary erosion in score-based instrumental music. The title "rill" refers to an imprint in the ground caused by the erosive effect of a soft, flowing stream of water. Degradation in digital media occurs at the bit level, below the symbolic level based on it, where composers with digitally set scores or musicians with electronic instruments exercise their control. Artifacts resulting from these profound changes typically lie outside the artistic concept and entail aesthetic ruptures, but on the other hand can provide impulses for new ideas.

The form of the piece serves as a plan for two musical elements: Melodies in polymodal space, and a delayed tremolo texture to "blur the distinction between dissonance and resolution."[26] The basis for the score is a series of twelve short modules that follow a harmonic scheme based on a descending mode: *c*, *a*♯, *a*, *g*♯, *f*♯, *f*, *e*♭, *d*.

The piece was formulated using the text-based notation language Lilypond. This way of representing scores provides formalized control over the music, or modeling of musical ideas in abstract form. In this way, the musical ideas used in the composition appear at the lowest level of representation as a stream of bits. Simple digital erosion processes in the form of stochastic bit flips were applied at this level, creating hundreds of variants of the piece over time. This manipulation of notation without any musically informed intentions creates variations outside of the usual schemes. However, an analysis of this erosion effect reveals that the effects are not erratic, but rather that certain elements of form continue to be amplified or exposed – not unlike the erosion caused by a steady trickle of water.

The progressive erosion processes also affect the readability of the score: more and more notational errors, i. e., unplayability, arise and require corrections by the perfor-

23 https://rottingsounds.org/antenna (30 Nov 2022).

24 Russolo 1916.

25 https://rottingsounds.org/rill (22 Dec 2022).

26 McCartney/Grill 2022, 201.

mers. Their efforts to make idiomatic corrections, i. e., corrections that fit the musical context of the composition, are made more difficult because they know that the errors have been created by machine – and not deliberate human – intervention.

Deep Time

The term "deep time," coined by John McPhee,[27] refers to the concept of "geologic time" which is used with the study of Earth's rock layers (strata) and layering (stratification). Typical time scales in this framework are of the order of 100 million years and more. The concept was later reused in the context of media by Siegfried Zielinski.[28] It serves as a metaphor to point to the stratifications of technological phases in the sense of "tectonic" flow – interpreting time, space, and communication as a kind of historical formation. The focus on media materiality has been further deepened by Jussi Parikka,[29] from the geophysical nature into hardware and energy with its various sociopolitical implications.

We have picked up the metaphor of "deep time" for our own research, in order to point to a time beyond our own control and to symbolize a time horizon where forces of geological scale will instead take over the transformation of human artifacts. Through the factual existence of fossils as remains of geological age, we can rightly speculate that information in the form of human-made structures such as music inscriptions may survive even those time spans – but not without experiencing considerable transformation over the duration.

When speculating about the dissemination of media artifacts over (extremely) long time spans, interpretation difficulties arising through a (potentially complete) loss of sociocultural context come into play. As an attempt of artistic tangency, the transdisciplinary narration *Voicings of an Auralist – a series of transmissions from an unknown source* was developed by Till Bovermann, Almut Schilling, Thomas Grill and Tobias Leibetseder over the span of the years 2020 and 2021.

After a flat, circular artifact reminiscent of a compact disc had been found in Vienna's Auer-Welsbach Park back in June of 2019 (see figure 5), it took quite some analytical work to determine that it was indeed a digital data medium containing a lengthy message of unclear origin. The interpretation of the found fragmentary message, encoded as a digital audio recording,[30] has to this day remained a rather fuzzy affair. Without knowledge of the recording's context, translation attempts must necessarily remain mere approximations. The process of forensic analysis and likely interpretations of the content of the artifact were released as a text[31] and as a radio play[32] developed for *Ö1 Kunstradio* of the Austrian Broadcasting Corporation (ORF). The found artifact along with its contained audio message has been preserved as a sculptural media installation.

27 McPhee 1980, 29.

28 See Zielinski 2006.

29 See Parikka 2015.

30 https://archive.org/details/auralist (30 Nov 2022).

31 Bovermann et al. 2021.

32 http://www.kunstradio.at/2021A/21_03_21.html (30 Nov 2022).

Figure 5: Discovery of *Voicings of an Auralist* at Auer-Welsbach Park in Vienna

The project's overall artistic research was accompanied by the mixed-media sculpture *Fragments*,[33] which consists of materials that have "fallen off" (in the sense of "offal") of the process in various ways. Waste, things collected, things stored and things put aside, texts, pictures, data, sounds, etc., are the basis of the shape-changing work. It was originally located at the *Auditorium of Rotting Sounds*. No distinction was made between "unwanted" accompanying material (packaging, etc.) and media on digital media that was purposefully and possibly elaborately created in the project. In its inherently transformative nature, the sculpture takes on most diverse forms, as a processual installation, as experimental sound and film, as a series of transformative performances, as sculptural multiples, as a digital publication[34] and as an art book.

The basic idea was to process the research process and its material concomitants via various dissemination processes for a "handing down." The titular, fragmentary form seems only logical in the perspective of long time periods and the expected decomposition processes. These transformational phenomena are amplified through explicit material stratification techniques as part of the installation, through fermentation rituals in performance events, but also through a thorough processing of the accumulated substances for sculpture multiples and the art book's paper making. The book's graphical content will be the book's paper, interspersed with fragments of multi-year research practice, and overlaid by a textual layer consisting of a three-perspective introduction by the core research team and a poetic-ethnological main part by the invited author Burkhard Stangl.

Throughout the years of research, not only have all sounding experiments been continuously streamed into the internet – an automatic process has also captured a sample of sixty seconds of audio for each hour and each installation. This *Rotting Sounds Archive* has accumulated to over 200,000 of such samples, corresponding to three terabytes worth of data, which can be browsed through an online interface.[35]

33 https://rottingsounds.org/fragments (30 Nov 2022).

34 Leibetseder et al. 2022.

35 https://mdw.ac.at/rottingsounds/public/archive (30 Nov 2022).

Although this data has also been processed into the *Fragments* sculpture and book through tiny fragments of digital LTO storage tape, another form of archival representation has been realized in parallel: The long-term installation *Inscriptions from the Archive* (2020/21)[36] by Hannes Köcher and Thomas Grill consists of a laser-engraving robot with read access to the *Rotting Sounds Archive* (see figure 6). It autonomously moved along the wooden backrest planks of the auditorium benches, randomly chose a sample from the digital sound archive for each plank and engraved a spectrogram representation along with some textual metadata of it into the surface. Steadily, over the course of several months, a representative selection of the sound archive has been inscribed into the 1000 planks of the auditorium, transforming the digital IT-based into a graphical wooden archive. The robot is also equipped with technical facilities to convert the inscriptions back into sound. The actual application of these facilities shall be left to a future archeologist.

Figure 6: *Inscriptions from the Archive*

Conclusions: Insights and Consequences

In trying to realize the Rotting Sounds project's guiding principle of "embracing the temporal deterioration" of digital (and also analog) sound, a major challenge became apparent: how can deterioration processes in "controlled" experimental settings be maintained? A paradigm of "letting go," therewith enabling temporal transformation of a yet to be discovered manner forbids any active intervention. In the maintenance practice in the *Auditorium of Rotting Sounds*, the question of when a system is considered "broken" (in the sense of the system's conception) or has just entered a different state worth to be further examined arose frequently, and was to be resolved each time in a most investigatory and context-aware manner.

It has also turned out that the "closedness" of a system in a thermodynamical sense is challenged by the auditorium's sonic environment, forming a "soundscape" of interweaved audio sources. Since the individual systems – due to their recurrent nature – are

36 https://rottingsounds.org/inscriptions (30 Nov 2022).

extremely sensitive to external influences, every tiny vibration can potentially influence a state which is then amplified over many iterations, typically for weeks and months. The above mentioned installation *Dust a bit* is one such example, but also *Phase transitions*[37] by Dario Sanfilippo. This sonified numerical simulation of a non-linear differential equation bears the realistic potential of an induced "butterfly effect"[38] to completely overturn long-term behavior. As a consequence, we have launched multiple runs for these systems, documenting the changing sonic behavior.[39] Nevertheless, the causes for the changes cannot be easily attributed to one specific effect.

The individual experimental systems can be seen as micro-eco-systems in which site-specific, time-dependent entities are acting, and – obviously – also reacting to and interpreting each other within their environment. Those conceptual entities are based on physical and logical (information) materialities. Fernando Domínguez Rubio differentiates between things and objects and describes the process of maintenance as the prevention from destroying the link between the thing and the object, consequently reducing its readability.[40] The *Auditorium of Rotting Sounds* has acted as a host for these processes of degradation and transformation. It served as an implicit archive in its own right, transitive with respect to the contained experimental systems' respective media . This perspective is motivated by Domínguez Rubio who refers to "things [which] are constantly falling out of place. Taking this fact seriously, […] requires us to think differently about the material world, it requires us to think ecologically, which means not to think in terms of objects but in terms of processes and conditions under which certain things are rendered possible as particular kinds of objects."[41]

Within the scope of our project, many different cases of degradation have been observed and documented. The individual transformation processes have been specific to the particular system design and its context. However, in the observation of these processes of decay it became clear that temporal transformations in digital systems are less gradual than in analog systems. This has also been observed by Jonathan Sterne in the context of sound carriers: "Where analog recordings fade slowly into nothingness, digital recordings fall off a cliff from presence into absence."[42] We have termed the abrupt degradation of digital media as "Sterne's cliff," explaining its nature with the operation of error correction mechanisms as a counteraction to the unavoidable, underlying analog degradation. Sophisticated algorithms can sustain information integrity (or simulate estimates) as long as the physical foundation provides sufficient support. When this is no longer given, the system tips abruptly. These differences between analog and digital systems also affect the aesthetics of sonic content.

For the purpose of illustrating key epistemological objects of our research, we introduced the concept of "digital trinity." The fictitious character of the "auralist," introduced above, describes it as follows:[43]

37 https://rottingsounds.org/phase-transitions (30 Nov 2022).

38 See Lorenz 2000.

39 https://rottingsounds.org/2020/06/07/dust-a-bit-rec (30 Nov 2022).

40 See Domínguez Rubio 2016.

41 Ibid., 76.

42 Sterne 2009, 64.

43 Bovermann et al. 2021, 105.

> [Listening closely | Listen carefully], digital turns out to be [threefold | triple].
>
> There is "data", a [description that is] symbolically [encoded description | encoded]. In [the case | terms] of sound, it may consist of a series of numbers representing the [deflection of a] speaker cone [deflection] at a given time, but [it] may [as well | also] be a set of rules [on | about] how sonic qualities [could | can] be [derived | obtained] from environmental factors.
>
> There is "hardware", [the] physical [boards populated | board is filled] with [semi-|half-] conductive components, connected with [wires | cables], both printed and [free-running | running freely]; [spinning | rotating] magnetic discs, sometimes magnetic [tapes | bands], microphones and loudspeakers. They form [a] complex [system on which | systems where] data is stored and processed.
>
> There is [the interpretation level | a level of interpretation]. Data storage is [so general, so | very common, very] abstract (almost always in binary code) [so] that an interpretation [guideline | recipe | codec | algorithm] is needed to determine how it is [turned | converted] back into sound.
>
> The [borders | boundaries] of these classes are [fuzzy: interpretation | unclear: interpretations] can be [hard-coded | coded] into [wires | cables], or, as [it is the case] with error correction, data [may | can] contain information [on | about] how it [should |would] be read. One factor informs the other, nothing can be [examined independent | checked regardless] of the other.

Within our reflection on time and its traces inscribed into digital (and the underlying physical) objects, we developed the notion of "digital patina"[44] as a poetic narrative for data-bearing material in its temporality, emphasizing the specific aesthetics of degradation in digital technology. The concept of patina refers to aesthetics of transience and characterizes changes in the material over time due to intrinsic and extrinsic influences. It adds value through historic testimony and uniqueness, and it can be understood as an expression of an artwork's "aura."[45] The concept of the patina may be perceived on a physical, aesthetic, and temporal layer. The "myth of the digital" declares bit-wise perfection and denies the physical fact of degradation, and consequently neglects an aesthetic beyond this pure perfection. In this narrative, digital existence is liberated from physical matter and its implied transience. The derived oxymoron of the "digital patina" reflects real degradation processes in digital space and points to sound aesthetics of such permanent transformation. This is an attempt to manifest a new self confidence of the digital beyond glitch aesthetics. There is a truth, an aura, which is proven by its decay. In analogy to a geophysical existence, the digital exposes stratigraphical characteristics and is therefore subject to erosion. This narrative enables novel perspectives on the different layers of the digital existence, the "digital trinity" and its symptoms of decay. Transience is inherent in anything and "anything becomes aesthetic with time."[46] Truly long-term (deep) observations within the digital realm would need to be conducted to possibly falsify this statement.

44 See Schilling 2020.

45 See Benjamin 1969.

46 Dieter Roth cited after Grothe/Ihrig 2016, 63.

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