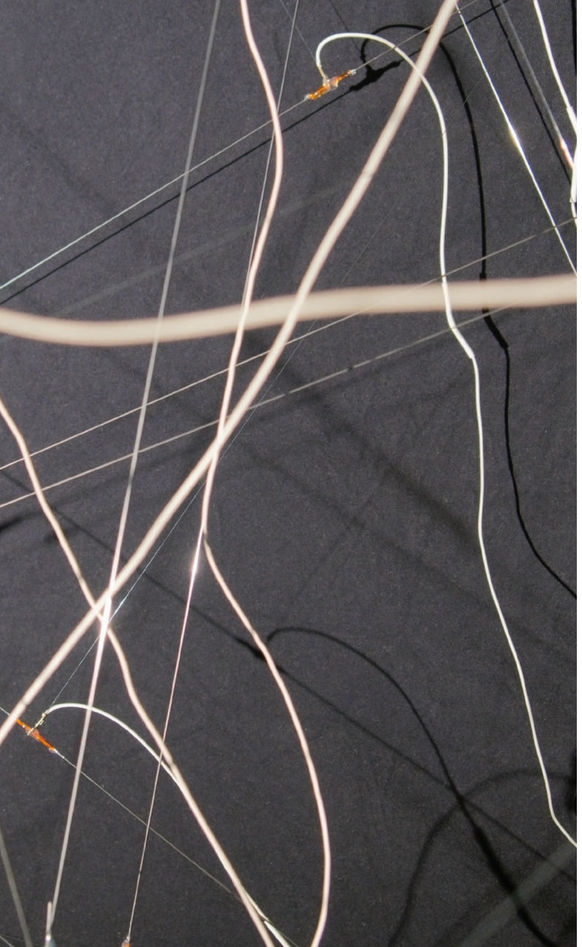

Navigating Noise means getting off the beaten track in order to find, or rather, to create something new. This publication is the result of such unconventional navigations, which follow the track of noise on its path across art, science, and the humanities. The point of departure is the artwork *Navigating Noise* by Kerstin Ergenzinger. This ephemeral, somewhat out-worldly sound installation provides the framework for a collection of academic and artistic contributions that address the need for alternative means of orientation to deal with noise and to understand and (re)establish our unstable position within a highly technologized, mediated, and globalized reality.

These navigations cover a broad terrain of research: from the starry skies to the deep oceans, from the ice cores of Greenland to sonic navigation in the animal kingdom, from spatial acoustics in World War I to noise music. Through a multidisciplinary approach, *Navigating Noise* paves the way for unexpected connections between research domains located at the border of knowing and not knowing. This endeavour tries to dig through and below existing semantic and epistemic systems. The contributors scrutinize the binary dichotomies of noise/information, noise/meaning, and noise/silence in order to reconfigure the relational framework that is constituted by these dichotomies. Released from this, noise no longer serves as the unwanted, semantic-free, and inefficient antithesis that should be discarded, but rather embodies a dynamic, unpredictable, yet constitutive force with which we can soar towards more agile forms of sonic sense production. Noise is the dynamic condition of the possibility for any form of meaning. It is through the navigation of noise that we are – figuratively speaking – able to 'know'.

With contributions by:
African Noise Foundation, Lino Camprubí, Nathanja van Dijk, Kerstin Ergenzinger, Felix Gerloff, Paul Hegarty, Seth Horowitz, Tim Ingold, Eleni Ikoniadou, Christian Kassung, Brandon LaBelle, Thomas Laepple, Heike Catherina Mertens, Patricia Pisters, Wolfgang Schäffner, Sebastian Schwesinger, Martin Skrydstrup

https://soundcloud.com/navigatingnoise

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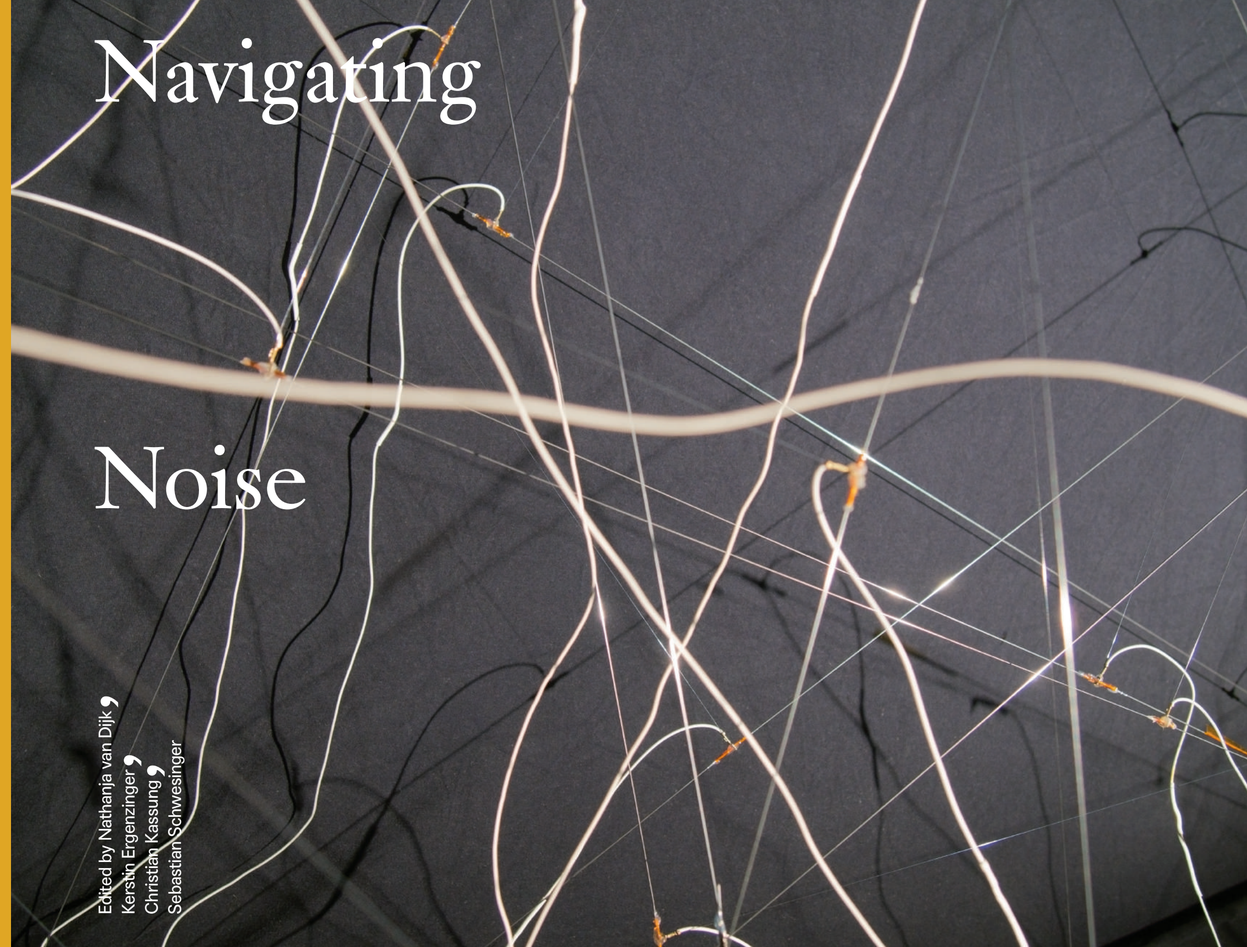
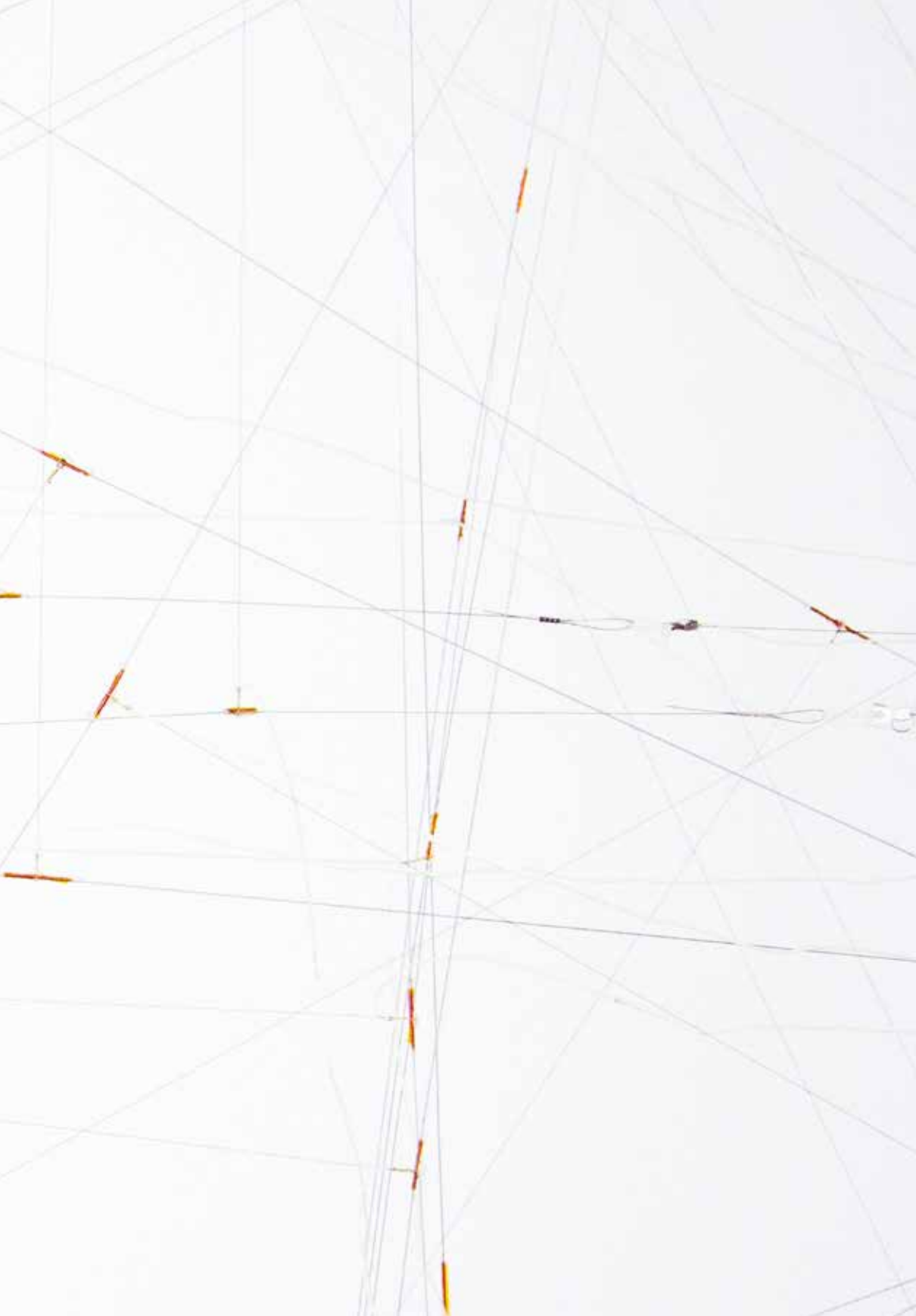
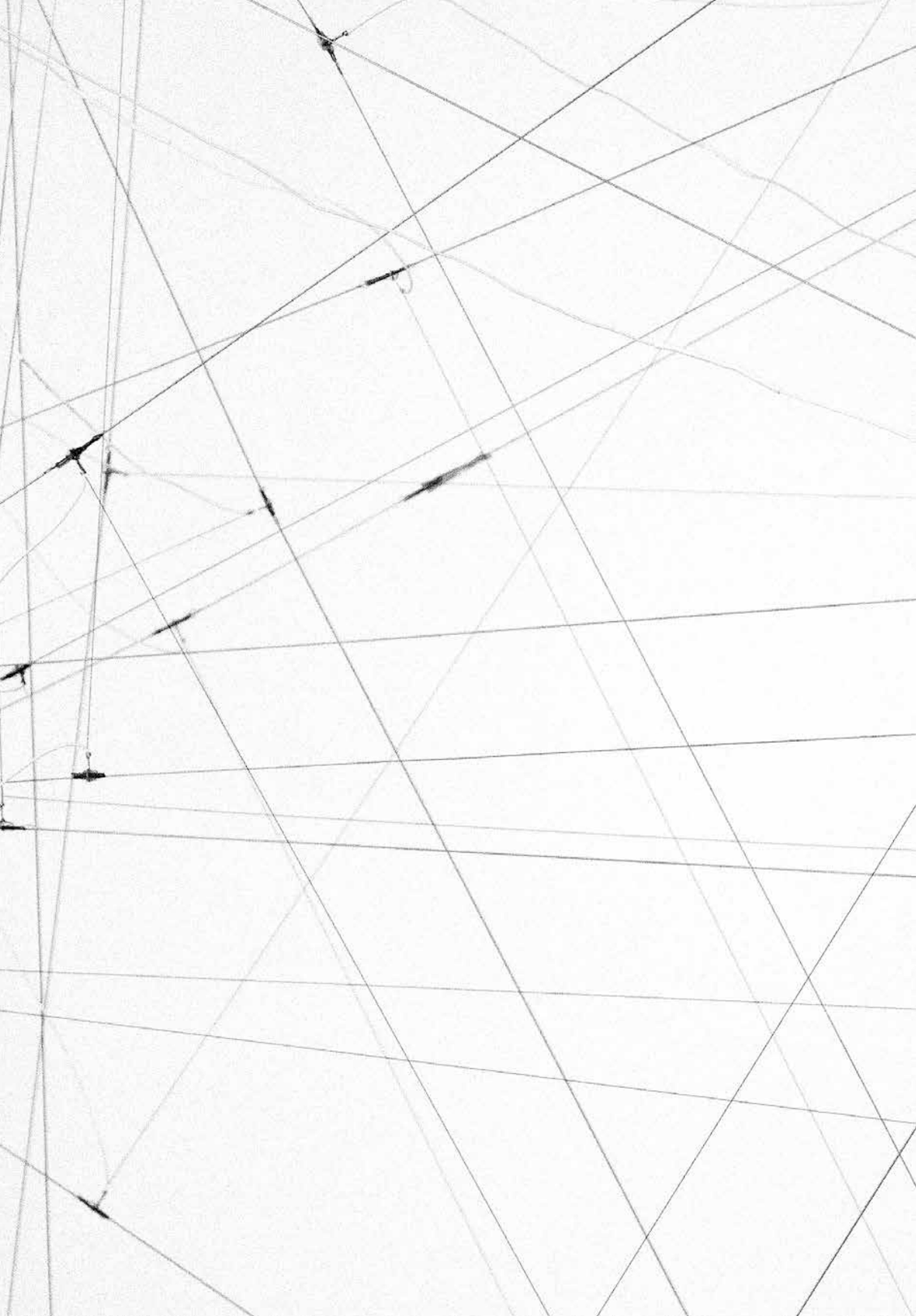
Navigating Noise



Navigating Noise

Edited by Nathanja van Dijk, Kerstin Ergenzinger, Christian Kassung, Sebastian Schwesinger





Navigating Noise

Edited by
Nathanja van Dijk, Kerstin Ergenzinger, Christian Kassung,
Sebastian Schwesinger

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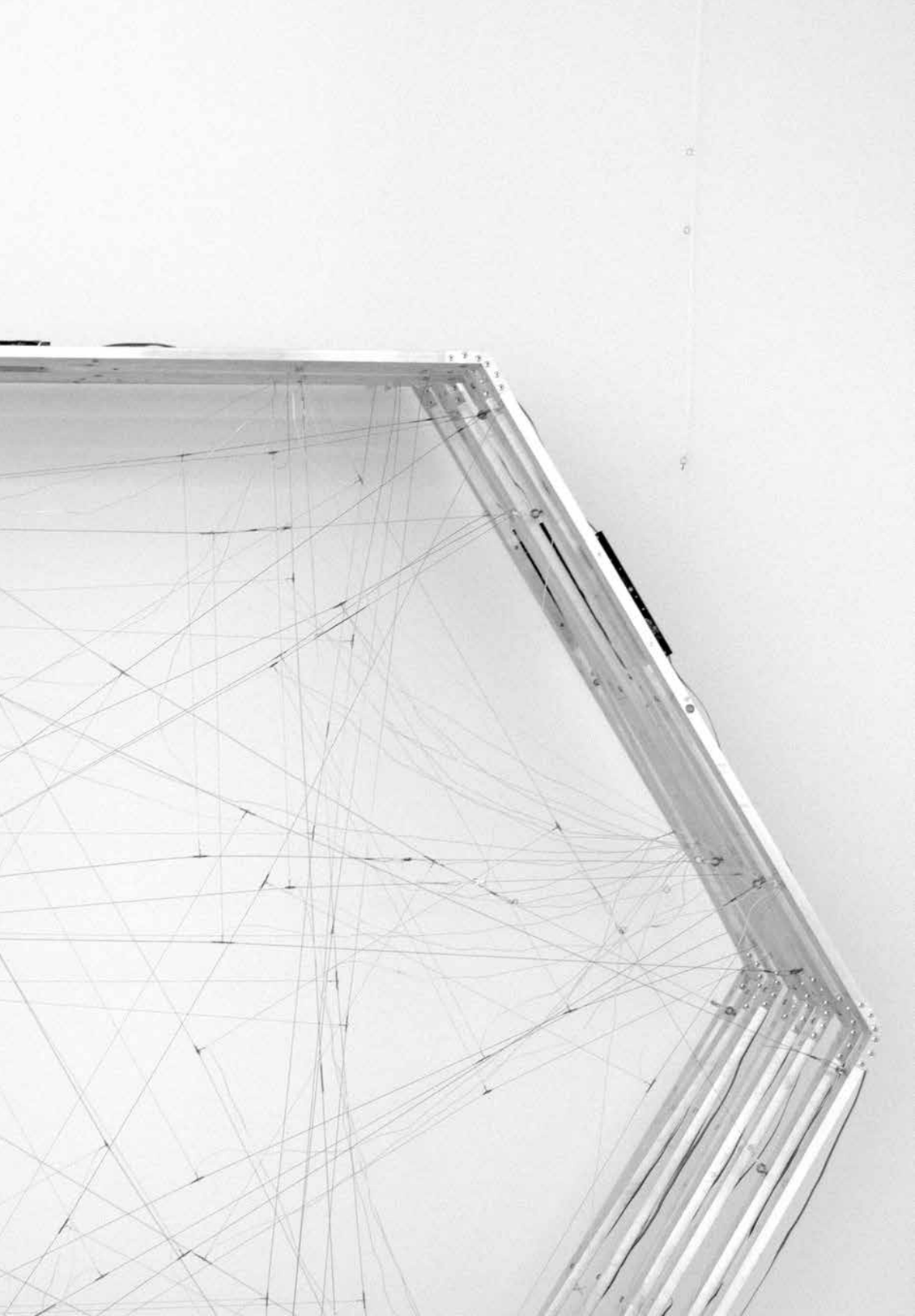

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Foreword by Heike Catherina Mertens

The Poetry of the Subtle

It is often the more quiet, minimalistic artworks one discovers in the midst of large art fairs or group exhibitions that cause a tone to sound within us, a tone which then begins to echo and, still resounding, initiates a concert of associations and further sounds that inscribe themselves upon our minds. When I first met Kerstin Ergenzinger in 2014 and began to look through her portfolio, I encountered a work I had already seen: *Studien zur Sehnsucht* ('Studies for Longing'). Composed of a series of grey rubber mats piled one on top of the other on the ground and able to be put in motion by a mechanism invisible to the visitor, the artist has constructed a landscape which functions as a projection screen for all of our various longings connected to formations of mountains and earth. It is an extremely poetic work, a work which is only able to have such an intense effect on the viewer thanks to the utmost precision with which Kerstin Ergenzinger has transformed her scientific studies into what are technically highly complex installations whose minimalist forms and carefully chosen materials carry an outstanding artistic signature.

By the time of our first meeting, Kerstin Ergenzinger had already been working with the physicist Thomas Laepple on the installation *Navigating Noise*. Up until that point, the work had been suspended in pieces on her living room ceiling, but it had reached a stage of development that necessitated a larger space for it to be fully realized and tested. Together with curator Nathanja van Dijk, director of A Tale of Tub in Rotterdam, we began to speak about trying a test set-up at the Schering Stiftung in Berlin. *Navigating Noise* soon turned out to be an ideal project for our exhibition programme. The installation proved to be not only an exceptional example of contemporary sound art, which we regularly display in our project space and support at other art institutions, but also an interdisciplinary research project that had many points in

common with the Analog Storage Media laboratory group of the *Image Knowledge Gestaltung* Cluster of Excellence at Humboldt University, Berlin. Contact was quickly established. The key focus of the artistic and scientific research was the question: How do we orient ourselves in space with the aid of sound?

After intense preparations, in May 2015 Kerstin Ergenzinger's first solo exhibition in Berlin, *Acts of Orientation*, opened at the Schering Stiftung. *Navigating Noise* hovered right below the ceiling in a honeycomb-shaped structure that filled the entire room, greeting the visitor with noises and sounds. As in 'Studies for Longing', the design is minimalist, but here pieces of the complex technical network are visible. 130 metres of piano and nitinol muscle wire are connected to the honeycomb-shaped aluminium architecture, which serves as a resonance chamber. Upon more careful observation, the visitor can see how the nitinol wire sets the piano strings in motion, thus creating various tones. And yet, the control programme remains concealed.

Visitors are free to move about the room and navigate the sounds on their own. These synthetic sounds simulating everyday noises from animals to the buzzing of power lines have, however, been programmed in such a way that their abstracted nature leaves listeners with only themselves as a point of reference. *Navigating Noise* is a one-to-one installation in which the ever-changing relationship between human beings, space, and sound best unfolds when visitors find themselves in the room alone and 'trail after' the sounds or follow them by means of their own movements. For *Navigating Noise* is a poetic and subtle study of our spatial awareness and simultaneously an experiential space for our sense of hearing. As we know, our eyes and ears often deceive us as to the complexity of our visible and audible world. We see and hear only that which we are ready to perceive. Our day-to-day life is overlaid with the sounds of our technological and digital world, and the buzzing of our smartphones has long replaced the nightingale as the background noise we hear in the night.

Starting with *Navigating Noise* as a space of artistic research, Kerstin Ergenzinger, Thomas Laepple, and Nathanja van Dijk then laid the foundations for this publication with their interdisciplinary research project Acts of Orientation. The conference of the same name that they organized in collaboration with the Analog Storage Media research group of the *Image Knowledge Gestaltung* Cluster of Excellence, which took place in May 2015 at Humboldt University, has also found its way into this book in the form of numerous contributions. The importance of the questions posed by all of our contributors as to how we orient ourselves in space through sound becomes explicitly clear when considering, for example, how the automobile industry is working under significant pressure to find intelligent solutions for making electric cars audible in order to limit the growing number of traffic accidents.

First and foremost, I would like to thank Kerstin Ergenzinger for her wonderful work *Navigating Noise*, which has given us a space for aesthetic (self-)experience. Nathanja van Dijk deserves special thanks for having organized the exhibition, conference, and publications. Next I would like to thank Wolfgang Schäffner, Christian Kassung, and Sebastian Schwesinger of the *Image Knowledge Gestaltung* Cluster of Excellence at Humboldt University, Berlin, for their magnificent teamwork – both within the framework of the Acts of Orientation conference and on this current publication. My sincere thanks as well to all of the authors and contributors involved in the joint research for the book *Navigating Noise*, as their openness and their artistic as well as humanistic and scientific research led to numerous extraordinary insights, many of which are documented in this work.

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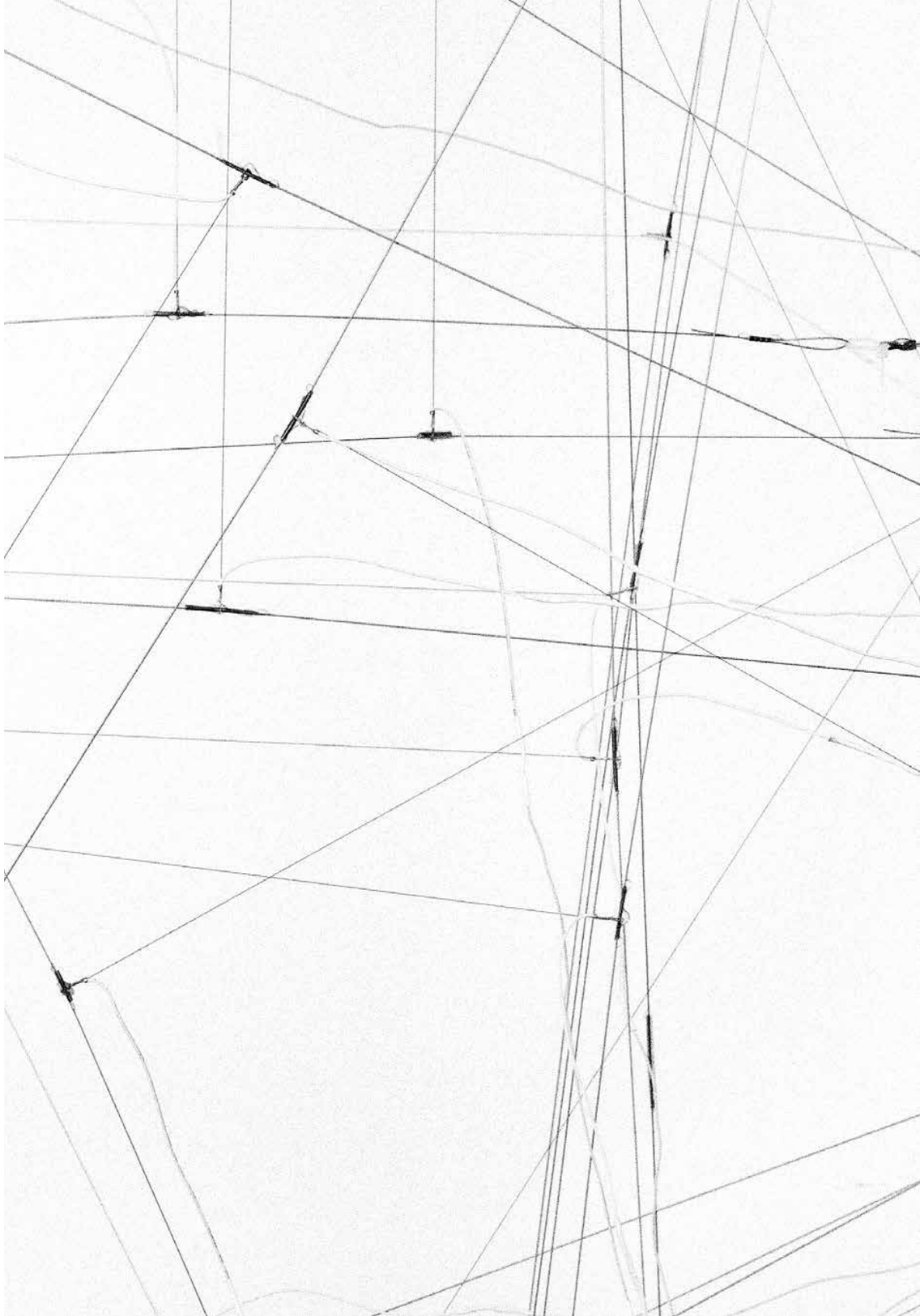

Kerstin Ergenzinger, *Acts of Orientation, palms and lines of the hand.*

Foreword by Wolfgang Schäffner

The Functionality of Sounding Spaces

How do we navigate? Let's take what happens while driving a car, for example. Jumping in the driver's seat, we close the door and isolate the car interior against the rest of the world, at least in one respect: acoustically. Almost the entire interaction of navigating a car through the labyrinth of a city is based on information that is processed via the optical channel: traffic signs, lights, the trajectories of other vehicles and pedestrians, streetscapes and roadways, and so on. It seems that only exceptional events or potential hazards, such as sirens, honks, or other piercing sounds, find their way through the acoustic shell of our car chassis, while the windscreen allows a free and focussed view of all processes and structures of the city that are necessary to enable successful navigation. Furthermore, the cockpit visually presents important information on the car's status, while the audio channel serves at best as a means of entertainment or private conversation.

This striking asymmetry of our senses, however, is in itself based on the distinction between implicit and explicit knowledge and - as one of the fundamental impulses in Western epistemology - a clear preference for the latter. Hence, taking the implicit modes of navigation into account as well, this leads to a much more balanced valuation of the optical and the acoustic channel. For our everyday orientation, navigation, and transportation, the subliminal perception and processing of a street's or a city's soundscape is essential. These acoustic structures are, however, much harder to isolate and analyse on a subjective level compared to incoming visual information. This may also be why, in historical disciplines, archaeological remains have been almost exclusively discussed with respect to their symbolic dimension. But as in our daily experience, of course, architectures shape sounds in order to serve certain spatial functionalities - ranging from natural rock formations to the anthropic architectures of city squares or immediate

audio technologies such as noise barriers. Rock formations have been used by the indigenous peoples of Southern Africa to amplify speech or song at their gatherings. The material structure of city squares may support speech intelligibility for public addresses or, on the other hand, create spaces for private conversations with an acoustically pleasant atmosphere. And noise barriers separate spaces by reflecting the sound of cars, for example, back to the place from which it came.

These examples show that, in the realm of sound, media and cultural techniques of transmission and storage are deeply intertwined. Architecture becomes operational, spaces operate as sound transmitters and thus actualise and shape a 'stored' functionality. The Analog Storage Media project of the *Image Knowledge Gestaltung* Cluster of Excellence investigates these interactions of sound phenomena both historically and experimentally. The Cluster of Excellence, an interdisciplinary laboratory comprising more than 20 fields of study, provides the ideal context for performing this kind of project work. Collaborating with physicists, acousticians, archaeologists, and media and cultural historians, the project focuses on sound not only as a design object but as a means of *Gestaltung*, investigating the materiality and historicity of sonic knowledge in music(ology) and acoustics and its productive outreach in past and contemporary contexts, such as urban planning, solid state physics, or archaeological reconstruction.

In the context of this active space approach, Kerstin Ergenzinger's installation *Navigating Noise* was an operating architecture of this kind in a twofold sense. Firstly, as an art installation, it neatly worked out a sono-spatial configuration that questions harsh distinctions between signal and noise. And secondly, it served the purpose of bringing together scholars from different backgrounds and fostering debate on these issues. At the Acts of Orientation conference, noise was discussed as an inhibitor, impulse, or even a means of orientation through the shared experience of the artwork, which subtly but substantially modified the situational and institutional configuration, unleashing an intellectual vigour to which this publication now bears witness.

My special thanks go to the collaborating groups Analog Storage Media (media cultural historians and theorists Christian Kassung and Sebastian Schwesinger) and Acts of Orientation (artist Kerstin Ergenzinger, physicist Thomas Laepple, and curator Nathanja van Dijk) for their willingness to engage in this experiment that proved to be an extremely fruitful collaboration between the arts and science. I would also like to thank the Schering Stiftung, and especially Heike Mertens and her team, who initiated the contact, supported the conference, and thus fostered the cooperative work that has benefited both the Humboldt-Universität zu Berlin and the Schering Stiftung over the past years.

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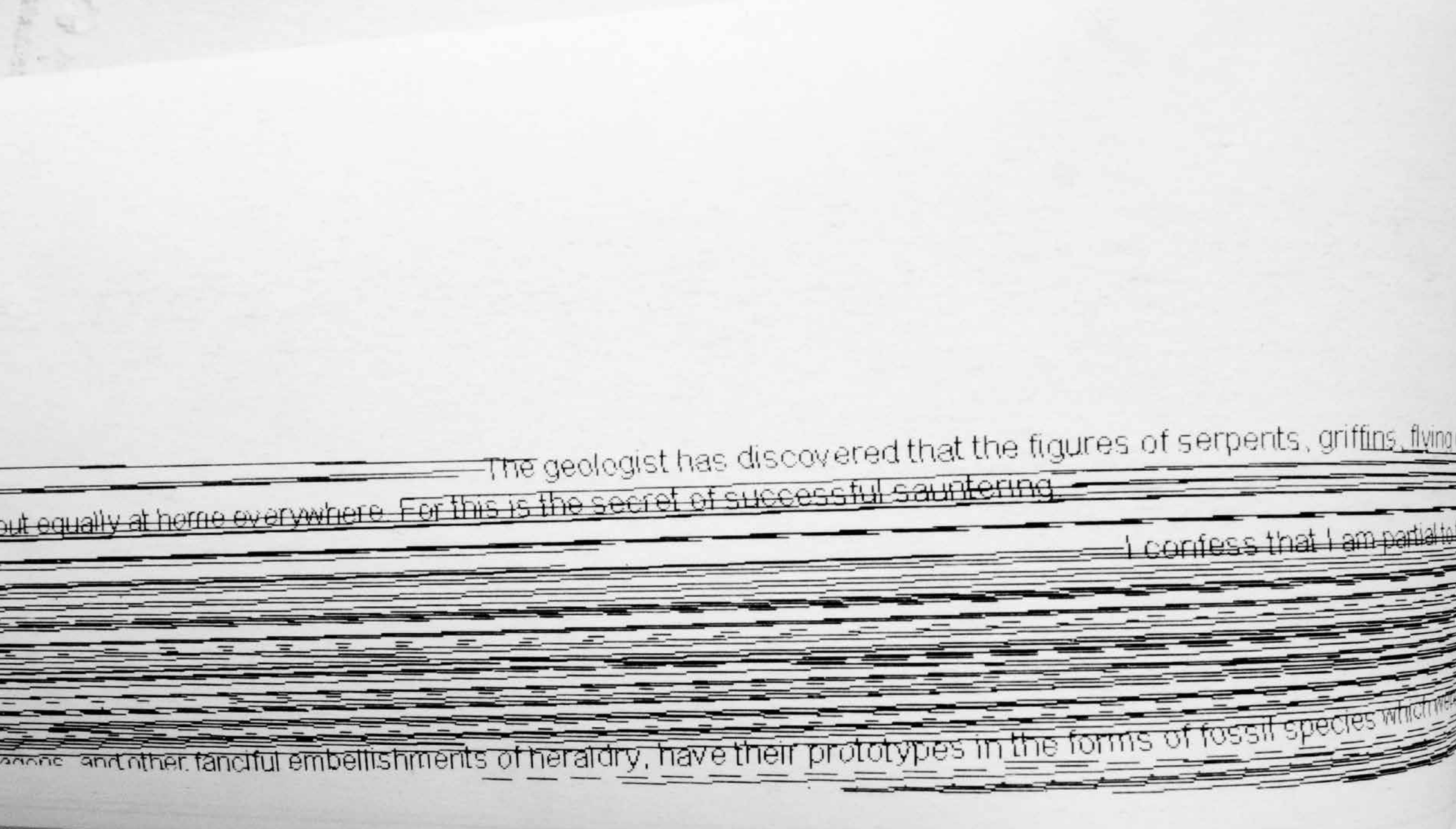

Kerstin Ergenzinger, *Acts of Orientation, Wanderer Prints*.

LEITMOTIFS

To Navigate Noise.

Introduction

Nathanja van Dijk.
On behalf of the editors

26.

To navigate noise is a leap in the dark: a rather brave move away from certainty to orient yourself towards the unknown, towards uncertainty, while not knowing where exactly you will end up. In other words, navigating noise means getting off the beaten track, entering unfamiliar and unpredictable territory at the risk of getting lost, in order to find or rather, create something new. These journeys without a known destination are inevitable when trying to make sense of the world, because meaning and knowledge are drenched in noise. Noise is the unpredictable, raw material where meaning and knowledge begin and where they end. Nevertheless, without demarcations, noise is only noise. Without navigation we are utterly lost on a vast plane where signal and noise are indistinguishable from one another. Therefore, adaptive means of orientation are needed to carve out new pathways in unfamiliar and unpredictable territory.

Navigating noise is exactly what we set out to do with this publication, which borrows its name from the artwork *Navigating Noise* by Kerstin Ergenzinger. The sound installation provides the framework for the collection of academic and artistic contributions in this publication, which addresses the need for alternative means of orientation to deal with noise and to understand and (re)establish our unstable position within a highly technologized, mediated, and globalized reality – a reality in which we have reached a level of noise we could have only dreamed of several decades ago. The diverse explorations in this publication work at the crossroads of noise as a theoretical and philosophical concept, and noise as a physical and sonic phenomenon, both within and beyond the boundaries of sound.

Our navigations cover a broad terrain of research: from the starry skies to the deep oceans, from the ice cores of Greenland to sonic navigation in the animal kingdom, from spatial acoustics in World War I to noise music. Through a multidisciplinary approach we aim to pave the way for unexpected connections between research domains located

at the border between disciplines, where knowing and not knowing meet and where we will need to dig through and below existing systems of knowledge and meaning. We scrutinize the binary dichotomies of noise/information, noise/meaning, and noise/silence in order to reconfigure the relational framework that is constituted by these dichotomies. Released from this framework, noise is no longer the unwanted, semantic-free antithesis that should be discarded, but rather a dynamic, unpredictable, yet constitutive force in which awaits tremendous potentiality. We argue that noise is the dynamic condition of the possibility for any form of meaning. It is through the navigation of noise that meaning is constituted and that we are – figuratively speaking – able to 'know'.

The publication is structured in three chapters: *Leitmotifs*, *Navigating Noise*, and *The Sonic*. In the *Leitmotifs* chapter we anchor the notion of noise in an anthropological and media-cultural terrain, approaching noise as a perceptual and a media phenomenon, respectively. We then wander off into the metaphorical world of the art installation *Navigating Noise*. Based on these explorations, we subsequently show that the investigation into 'noise as a sonic concept' leads to alternative modes of orientation in the chapter *The Sonic*.

Leitmotifs

The anthropological reflections of Tim Ingold provide us with a compass for our understanding of what noise could be. In his text *Noise, Sound, Silence* he questions how to tell all-encompassing noise from deafening silence by drawing an analogy with blinding light and being cast into complete darkness, between white and black. In his phenomenological account of noise, Ingold introduces 'pitch' as the sonic counterpart of the luminous beam. Pitch is the line of eruption that describes the trajectory of sound as it unfolds within experience. He argues that there is no 'pitch' without 'timbre' – the cast of sound itself – that captures the ordinal qualities of sound that overflow its measured

representation. When we bring together 'pitch' and 'timbre', we will be able to make the distinction between noise (white) and silence (the all-absorbing black), and only then can we start to comprehend the full spectrum of life, which is consumed by noise, yet begins and ends in silence.

Christian Kassung investigates the historical role of physics and media technologies in our changing notion of noise in his text *Falling Darts, a Lost Submarine, and a Blind Man*. He departs from the historical understanding of noise that has dominated the 20th century, when noise was considered to be the medium of sound. It was not until media technology of measurement and amplification became readily available to scientists and engineers that we allocated noise to the foundation of our material world. Based on three case studies, Kassung argues that while noise was being investigated as a physical phenomenon throughout the last century, it eventually became a media effect. Kassung traces these changing navigations of noise within diverse mediated contexts, in which our shifting perception of noise played a crucial role: the spatial acoustics of World War I, the oceanic surveillance of the Kursk accident, and the active echolocation of visually impaired humans.

Navigating Noise

At the heart of the publication, we arrive where it all began: the art installation *Navigating Noise*. In close collaboration with physicist Thomas Laepple, artist Kerstin Ergenzinger created a hybrid, somewhat outworldly artwork, a sonic architecture. Its soundscapes emerge from a honeycomb-shaped aluminium structure that hovers above your head in the exhibition space. Through this structure, Ergenzinger has interwoven over a hundred metres of piano and robotic muscle wire that is set into motion by digitally controlled input frequencies. As a result, the installation is brought to life by the vibrating piano wire and the resonating aluminium body, creating an endless range of sound qualities. When you move

through the space, the soundscapes constantly shift their tone of voice, translating your whereabouts into changing acoustic fields that simulate man-made and natural sonic phenomena.

Navigating Noise can be best described as a poetic exploration of how to orient oneself in space through sound. We are being challenged to reflect upon the intricate connection between the senses and the role of our body within the sonic event, while simultaneously coming to terms with the noisy and dynamic character of the work. Moreover, *Navigating Noise* constitutes a metaphorical space, where listening means hearing as well as understanding, where sensing and sense-making merge – a metaphorical space in which a physical, sensory experience is linked with an abstract notion of noise, drawing a parallel with the way we approach the world and the need for orientation in our continuous search for meaning. In the chapter *Navigating Noise* we wander off into the sonic world of the art installation, which is the point of departure for our further explorations of noise.

Ergenzinger's ongoing artistic research into noise, navigation, and orientation – which underlies the development of *Navigating Noise* – is represented by a selection of drawings from her series *Acts of Orientation, palms and lines of the hand* as well as the 'foot-prints' of her artwork *Wanderer* that meander throughout the publication. The series *Acts of Orientation* consists of intimate drawings, in which the artist has set herself the almost impossible task of meticulously following the lines of the palms of her hands, based on the idea that through our senses we can interrogate ourselves as beings in the world. During this process of orientation between her body and the perception of her body, between sense and 'made sense of', the artist is constantly on the brink of getting lost. *Wanderer* is an installation of modified small thermo-printers that 'walk' like little mountain climbers across strips of thermal paper stretched in the exhibition space. The little printers leave a trace on the paper, poetically documenting their journeys in lines, dots, and words.

With the poem *White Noise in Eight Amplified Movements (for Clarice Lispector)* that was inspired by *Navigating Noise*, African Noise Foundation gives a beautiful account of noise as 'the most naked thing in existence', which resides in us and surrounds us, but is never to be known. Any attempt to capture noise is futile. When doing so, it will no longer exist for you. However, noise will never forget about the open window somewhere in the back of your house and will always find its way back in.

During a day-long conversation, Kerstin Ergenzinger, academic Patricia Pisters, and curator Nathanja van Dijk embarked on an exploratory journey through the soundscapes of *Navigating Noise*, leading through the realms of art, science, philosophy, and back again. The text *Wandering Off* is based on their conversation, in which they discussed the need to hear noise beyond the layers of order and unity that we have imposed upon our world, about bodies without organs as well as bodies in the world, about the act of walking, and about navigating noise as a fundamental component of our engagement with reality.

The 'earwitness report' *An Ecology of Noise. Three Orientations* by Brandon LaBelle is an imaginative and personal account of his encounter with the artwork *Navigating Noise*. He portrays the work and its complex unfolding as an ecology of noise, one that he details by way of three orientations: stars, labyrinth, and reflections. These orientations offer us speculative pathways into the work's *eventness* that at the same time unfold beyond the work, to reach for associations and spectralities. LaBelle approaches the installation as an extended body of related singularities to highlight its aesthetic of multiplicity, as well as his own place within it. Moving in and around the installation, the work acts as a floating coalition – a structure that gives residence to matters and memories, actualities and associations.

Eleni Ikoniadou's experience of *Navigating Noise* led her to think about the capacity of aesthetic experience to generate change and about the power of a sonic artwork to probe larger theoretical questions. In her text *Sono-Aesthetics* Ikoniadou calls for a new and adequate theory of art and aesthetics within our age of absolute computation, without privileging human experience nor completely exterminating relationality. There is a place for aesthetics in devising alternative theories and mythologies today. Furthermore, by plugging into the sonic, it might be put to use as a form of re-orientation proper to the study of the present. Sound, she argues, offers a way out of the binary dichotomies between nature and culture, material and immaterial strata, human and machine entities. This is because within the sphere of the sonic event, such as *Navigating Noise*, our traditional notions of what it is to be human, what constitutes consciousness, the boundaries between concreteness and abstraction, and more, all become unstable and uncertain. A new sono-aesthetics can allow us to find something radically new, to account for a sonic event as able to express the memory of an unlived reality, arriving at us whole and intact, yet never before experienced.

The Sonic

In connection with Ikoniadou's pledge for a new conceptualization of the perceptual sonic event, Felix Gerloff and Sebastian Schwesinger develop a concept of sonic thinking that embeds such sound-evoked sense-making in dispositive structures. In their text *What Does It Mean to Think Sonically?* they argue that by following the precise chains of 'transpositions' of sound events – through their particular physical and technical properties, cultural semantics, bodily perceptions and affects, and renderings in text or speech – the important characteristics of specific historical forms of sonic reasoning and modelling can be determined. Noise is an important manifestation and differential category of sonic thinking, and it specifies the essential challenges that have led to the particular formation of dispositive structures. In the form of techno-sonic noise, the authors historically trace noise's productivity for the measurement of loudness. In a second example, they detect a historical transformation with the discovery of aelectro-sonic noise, which established an electromagnetic image of the world as a global system. Navigating noise, they

argue, is thus an attempt to make sense of liminal phenomena where existing lines of thought and strategies of appropriation lead to difficulties or simply are not feasible.

Gerloff and Schwesinger's notion of 'noise as a sonic figure of thought' provides the conceptual foundation for the following interdisciplinary discussion of the importance of noise in climate research (Skrydstrup/Laepple), neuroethology (Horowitz), noise music (Hegarty), and the sonic construction of the oceans (Camprubí).

The text *Navigating Noise at NEEM* immerses us in the world of deep ice-core drilling on the ice sheet of Greenland. Martin Skrydstrup and Thomas Laepple explore what role sound may play in knowledge production about the planet's past climate. As their exploration is conducted from the perspectives of cultural anthropology and climate science, respectively, they first reflect on how sound has been and is treated in both of their disciplines. They then work alongside and with the scientists at NEEM to chart how sound is animated and becomes significant in scientific work. They render narratives about the sounds of ice in champagne glasses and in conversations, in the drilling hole and in the sub-surface science trench, where many surprises loom large. If all the processes taking place throughout the camp are taken into account, the visual and the aural are mutually constitutive for reading the climate signal in ice.

With *Trying to Hear the Way*, Seth Horowitz gives us a neuroethological perspective on noise and signal in auditory navigation. Through ornate examples ranging from bullfrogs finding the perfect mate to NYC cabbies looking for their way to JFK airport, Horowitz shows that at the heart of every form of navigation is the ability to identify and discriminate signal from noise. Their role in navigation is highly complex and often interleaved depending on the task, the environment, and the species involved. Acoustic navigation is thought of as a special case, as humans are visually biased and sound is so variable in our normal environment. However, Horowitz illustrates

that sound is often one of the most common and successful modalities for moving about in non-human species, through his meticulous description of how microbats use sound the way humans use vision. Although mechanisms for dealing with noise and moving through the environment are highly complex and prone to error, it is the emergence of anthropogenic effects in these environments and the human role as noisemaker that pose their greatest challenge.

In his text *The Empty Signal. Noisy Channels and Noise Music*, Paul Hegarty argues that noise music can act as a critical method and be used to read other ideas about noise and music. Noise is a judgment, a social one, about what is noise and what is sound. Noise is what we define it to be, and noise music is an attempt to keep noise noisy. Hegarty pursues communications theory – departing from as well as undermining Shannon and Weaver's models – by considering the existence of noise music as a genre that does not want to be one, and harsh noise wall as a rejection even of noise music. By examining the developments in noise music and ideas of noise from the Big Bang, through the Futurist Luigi Russolo's art of noise, to noise as an expression of the modern condition, he moves away from exploring entropy as disorder to thinking of it as the statistically natural state of all being. 'Total noise' in music acts as an advance on this thought, one that stimulates an extension of the idea of noise away from communications theory and into a more cosmological state of being. Hegarty concludes by hinting at where to look for noise in the 21st century, where noise is not-this, not-that, not-quite, not-here.

In *The Sonic Construction of the Ocean as the Navy's Operating Environment*, Lino Camprubí submerges himself in the ocean, following the navies across the globe that turned the underwater world into a human environment from the 20th century onward. For submariners and submarine seekers, making themselves at home in the ocean meant turning it into a soundscape and adding new noises to the long list that humans were already responsible for, such as engines

and drilling. In order to map and navigate the noisy environment, sound archives and catalogues became crucial. However, Camprubí shows that the oceans were sonorous long before mankind filled them with sonic technologies. Whales, for example, turn pressure waves into audible waves through an ear system very similar to that of terrestrial mammals. The main issue at stake here is how the different animal *worlds* interact, how they actually refer to a single world filtered at different scales. The human sonification of the oceans has put military sonar into competition with echolocating animals. Camprubí argues that while humans have turned cetacean noises into signals useful for navigation and mapping the ocean as a territory, our signals are, for echolocating animals, the most deadly noises.

Hum and thrum

Through the diverse navigations in this publication, we have set foot in a wide variety of unfamiliar terrains in order to reconceptualise our understanding of noise from multiple perspectives. Entering unfamiliar territory requires unconventional modes of operation, which we believe can be found at the intersection of disciplines. Therefore these navigations – initiated by the Acts of Orientation research team and preceded by an exhibition and conference – could not have been possible without our partners: Image Knowledge Gestaltung Cluster of Excellence at Humboldt University and the Schering Stiftung, as well as Stiftung Kunstfonds, who supported this publication. Furthermore, we are grateful to our exhibition partners A Tale of a Tub and the Mondriaan Fund. Above all, we would like to thank all the contributors to this publication for embarking on this risky and noisy journey with us. Together we have tried to track noise, following its path across art, science, and the humanities, fuelled by our belief in the need to reorient ourselves towards the hum and thrum of our complex and eventful world: a world in which noise and system, being and meaning are inextricably intertwined.

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Noise,

Sound,

Silence

Tim Ingold

Who can define what noise is? It is a word that points to the sheer impossibility of definition. If anything is something, it is not noise; if it is somewhere, it is not noise; if it is intelligible, it is not noise. In all these ways, noise appears to be the sensory equivalent of dirt. Where dirt, as anthropologists say, is matter out of place, noise is sense out of place – or in a word, nonsense.[1] It is a manifestation of the disorder of the world, of its entropic tendencies. And since noise is undefinable, it cannot define. It pays no respect to categorical boundaries. It makes concentration hard, focus impossible. It rocks the foundations of existence, condemning us to ride the ocean of sensation like landlubbers on the deck of a ship, heaving every which way in the swell. Indeed it is from the Latin *nausea*, with its reference to sea-sickness, that our word 'noise' is derived (Home-Cook 2015, 28). Yet precisely because of its formlessness, noise harbours an unlimited creative potential. Every cycle of life starts in noise, even if it ends in silence: between birth and death, noise and silence, lies everything of form and significance. In his *Principles of Psychology*, William James famously wrote that 'the baby, assailed by eyes, ears, nose, skin, and entrails at once, feels it all as one great blooming, buzzing confusion' (James 1890, 488). If that is noise, then it is not limited to the auditory realm but covers every possible way in which the world is present to the senses. In what follows, however, I shall limit myself to the 'buzz' of auditory sensation, though not without comparison to the 'bloom' of the visual.

1 The idea of dirt as matter out of place was first expressed in these terms by Mary Douglas in her work on purity and pollution (1966, 36). On noise as sound out of place, see Hendy (2013, x).

My question is this: if we begin in noise and end in silence, then how can they be distinguished? Or are they just the same? Do we end, in life, where we began? The paradox of noise is that it can be deafening. When noise is at its most intense, it is quite impossible to hear anything. Yet where nothing is audible, is that not silence? Both noise and silence, it seems, are experiences of hearing *nothing*. But hearing *something* – that, surely, is an experience of sound. Are noise and silence, then, two extremes of a continuum between which lie every shade and intensity of sound? If so, how are we to tell them apart? It does not help to observe that noise is … well, noisy! Or that silence is silent. Posed thus, in the field of aural perception, the conundrum has its counterpart in the field of visual perception in the question of how to tell day from night. Absolute silence is often compared to the blackness of the night. When it is pitch dark, and with neither moon and stars nor any artificial light for illumination, you cannot see anything. All around and in your head is black. But light can be blinding, just as noise can be deafening. The more blinding the light, or the more deafening the noise, the more it inclines to white. The counterpart of white noise is the whiteout of a snowstorm, or a thick fog, in which daylight visibility is reduced virtually to zero. Both the black of the blackout and the white of the whiteout are experiences of seeing nothing. In between, every shade and intensity of light affords an experience of seeing something. What is the difference, then, between black and white?

Resolving the conundrum takes us to the heart of the problem of what we mean by light and sound. Let's start with light. No-one seems to be able to say what it is. Physics tells us that light is an energetic impulse, radiating from a source as waves or photons. If that is so, then despite the name 'optics' having been assigned to the physics of light, we have no need of eyes for light to exist. All that is needed is a source. Nor, even, do eyes enable their bearers to see the light. What they see are things *in* the light. According to the ecological theory of visual perception proposed by psychologist James Gibson (1979), what matters for vision is not the light itself but the patterning that comes from the way its rays are reflected and refracted by surfaces in the world. The continuous modulation of these patterns, as they are picked up by the moving observer, is sufficient to specify the features of the environment that we actually see. When, in our experience, we see nothing, it is because for one reason or another, the patterning has been eradicated. This could be because the light source has been occluded, as the sun is at night, or because rays of light have been diffracted at random by particles of moisture in the atmosphere, as in a fog, with the result that any differentiation in ambient light that may have

specified environmental information has been dissolved. In this respect, as Gibson himself observes, there is nothing to distinguish ambient light from ambient darkness. Either way, we see not something but nothing – pure emptiness (Gibson 1979, 52).

It is the same with sound. Physicists explain that sound is a mechanical vibration in the medium, set off by some initial disturbance – be it the impact of one object on another or the friction of materials in movement – and emitted in all directions from the source. In this sense, sound has no more need of ears for its existence than light has need of eyes, and acoustics is as much a misnomer for the physics of sound as optics is a misnomer for the physics of light. What, then, do we hear? If we apply the same logic to aural perception as we have just applied to vision, then we arrive at a conclusion that is both surprising and counterintuitive. It is that the last thing we hear is sound itself. What we actually hear, and commonly mistake for sound, are patterns or invariants in the sonic milieu whose modulations allow us to identify events or properties of the environment.[2] When asked to report on what we hear, we tell not of the sounds themselves but of the objects and events they bring to our attention: a dog barking, a door slamming, a car passing. And when we report that we hear nothing – not even the dog, the door, or the car – it is because there is no discernible pattern in the acoustic signal. This may be because the signal has faded out or been occluded by a barrier, or because it has been completely scrambled by interference. 'White noise', as cultural historian Hillel Schwartz tells us, 'is patternless sound … rather than an olla of all sounds' (Schwartz 2011, 834). In their effects, black silence and white noise are no different. Either way, nothing is heard. With hearing as with vision, it seems there is no telling black from white.

2 One of the most thoroughgoing attempts to apply Gibsonian theory to auditory perception is by musicologist Eric Clarke (2005). One example he gives is of hearing a passing motorbike. The hearer is 'exposed to a continuously changing array of acoustical information, but within that array will be invariant acoustical properties, in a specific pattern of relationships, which together identify the motorbike and which remain constant under transformation' (Clarke 2005, 34).

Outside or inside?

Yet, manifestly, we *can* tell the difference. The contrast between being blinded by light and cast into darkness is palpable, even though in neither case can we see anything.

And so is the contrast between being deafened by noise and cocooned in hermetic silence, even though – again – in neither case can anything be heard. What, then, is the light that blinds, and the noise that deafens? They cannot be the energetic impulses to which physicists refer, for the ray penetrates only as far as the retina, and the sonic vibration as far as the eardrum. Might their sources rather lie within? Could the eyes and ears be sites not for the reception, respectively, of light and noise, but for their generation? If the senses are like keyboards, might the player be inside the piano? Much attention has been paid to the study of entoptic phenomena, such as the zig-zag streaks of light that presage an attack of migraine, or the 'floaters' that dart about in the eye, invading the field of vision.[3] That the eyes have their own lights can be confirmed merely by closing them for a moment and concentrating on the darkness of a field lit up by specks as innumerable as stars in the night sky. They have their counterparts in the repertoire of buzzing, hissing, and clicking noises that torment sufferers from tinnitus. All of us experience these noises to a degree, even if – for most of the time – they remain in the background. And as the composer John Cage repeatedly observed, total silence is impossible as long as the blood of the body keeps circulating and nerves remain on edge (2011, 10).[4]

3 Much of this attention has been motivated by the thought that it might have to do with altered states of consciousness associated with trance or shamanic experience, and their expressions in art. See Lewis-Williams and Dowson (1988).

4 For a commentary and references, see Schwartz (2011, 710–711).

Now clearly, closing one's eyes on a summer's day will not stop the sun from emitting radiation; nor will stopping one's ears quell the vibrations set off by an explosion. Light and sound, in their physical definitions, remain real and present even if you shut yourself off from their sensory impact. In these terms, the dazzle you experience behind closed eyes even in the absence of external light, and the buzz of nerves inside your head even in the absence of external sound, can be no more than visual or auditory hallucinations. To suggest otherwise, say physicists, is at best to be carried away by colourful analogy, at worst to peddle in illusion. Perhaps the dazzle and buzz are internal effects that mimic the effects of exposure to external luminary or sonic stimuli, but they are not light and sound in themselves. If, however, we allow that our dazzled eyes and buzzing ears do indeed fill our heads

with light and sound, and that there is no escaping from either – even in a darkroom or anechoic chamber – then, evidently, the physics will not help us. Could psychology offer an alternative? Are light and sound 'inside the head', rather than 'out there' in the world? Are they affectations of the mind? If that is so, then light is light, and sound is sound, whether or not it can be attributed to an external source. Thus the bang that I hear is a 'bang in the head', regardless of any explosion that may have taken place – if at all – in the world (Porath 2008, 647–649).

Classical psychology imagines that an impervious boundary separates mind and world and mediates all exchanges between them. That boundary is the body, including its sensory organs such as eyes and ears as well as the touch-sensitive envelope of skin. On the outside, the body is energetically buffeted by photoelectric radiation and by vibrations in the medium. On the inside, it experiences light and sound. This is a separation, however, that is belied by experience. We are inhabitants not of our bodies, but of a world. The body, with its organs of sense, affords an opening to this world, not a means of separation: it offers exposure, not immunity. Light and sound, then, are neither 'in here' nor 'out there', neither mental nor physical. On the contrary, the very experience of light, or of sound, is one in which the boundary is dissolved – in which mind and world, the sensing and the sensible, fuse together and, in so doing, constitute a field of perception. As the philosopher Maurice Merleau-Ponty put it, light and sound present themselves as 'kinds of symbiosis, certain ways the outside has of invading us and certain ways we have of meeting this invasion' (1962, 317). The symbiosis, if you will, is of the affective and the cosmic. Wherever the two collide – where our attention is let loose upon the world – there is ignited a kind of spark. Herein, says Merleau-Ponty, lies the continual birth of our visual awareness, that is, of light itself. But he could have said just the same of sound (Merleau-Ponty 1964, 163–164, Ingold 2015, 107–108).

Let us return to William James and the new-born baby, assailed as he says by blooming, buzzing confusion. Opening

its eyes upon the world for the first time, the baby recognises nothing. 'The first time we see *light*', wrote James, 'we *are* it rather than see it' (James 1892, 14).[5] Struck blind from that moment, the baby nevertheless knows something that its elders, recognising everything they see around them, have long forgotten: a sense of what light really is, in its first incarnation. Not until we find ourselves lost in a whiteout, rekindling the experience of that 'first opening', does the memory return. Could it be the same with sound? The baby is immersed in sound long before being exposed to light, for its auditory awareness has already developed in the bubbling, thumping, and gurgling environment of the womb. It is dark in there, but very noisy! Perhaps, in the experience of the unborn child, sound is not what she hears but what she is, until that moment of birth when she becomes a being of the light as well. Of course, we were all there once. And while we can only speculate as to what it must have been like, it seems that the primordial memory of sound has not been eradicated, in the minds of modern people, to the extent that we have lost the memory of light. The difference shows up in the radical distinction that is commonly drawn in so-called western societies between vision and hearing. We see *things*, it is said, but hear *sounds* (Ingold 2000, 244). Why is that? Why should the objects of vision appear broken off from the light that renders them visible to us, whereas the things we hear seem to be sculpted from the very stuff of sound itself?

5 James himself credits this insight to the eighteenth-century philosopher Étienne Bonnot de Condillac.

Making things out

According to a widely held view, vision sets things at a distance, in their proper places. And looking is a targeted act of perception. In their verb *skopein*, 'to look', the ancient Greeks compared it to shooting an arrow. But hearing, we are told, is immersive: it lets sound in, gathering if from every direction, and concentrating it at the very core of our awareness. We find ourselves not set apart but at the centre of our auditory world.[6] Now to this one could, of course, object that listening to things can be just as targeted as looking at them: indeed the one assists the other, since in swivelling the head to balance the auditory input from the source, our eyes are

6 'Sight isolates, sound incorporates. Whereas sight situates the observer outside what he views, at

a distance, sound pours into the hearer … Vision comes to a human being from one direction at a time … When I hear, however, I gather sound from every direction at once: I am at the center of my auditory world, which envelops me, establishing me at a kind of core of sensation and existence … you can immerse yourself in hearing, in sound. There is no way to immerse yourself similarly in sight' (Ong 1982, 72).

7

A similar argument is advanced by Jonathan Sterne, in his critique of what he calls the 'audio-visual litany', a suite of oft-repeated oppositions between hearing and vision (Sterne 2003, 15–19).

precisely oriented in its direction, helping us to pick it out. And conversely, the luminous experience of a whiteout can be just as immersive as that of all-around noise, just as constitutive of our existence as sentient beings. It seems that in their eagerness to contrast vision and hearing, scholars have inadvertently chosen to foreground targeted perception in the former case and immersive experience in the latter. This is hardly to compare like with like. Indeed, the alleged contrast between hearing and vision seems to have been introduced as a surrogate for a distinction of more fundamental ontological consequence, between the nascent experience of a world in constant becoming – as if undergoing continuous birth – in which things are ever on the point of emerging from the fluxes of their generation, and the retrospective review of a world of being, in which everything has already precipitated out and has fallen where it will, in this position or that.[7]

Thus, each time I identify a thing I hear with its sound, I am reminded of the work it takes to differentiate both myself as hearer and the thing heard from the continuum in which we were both primordially immersed. The thing has to be 'made out', and in so doing I make myself out as well, fashioning a self in the very act of hearing. Wrapped up in the sound of the thing is the memory of its once having been dissolved in an ocean of vibrant materials, and – wrapped in my hearing of it – is the memory of having been flooded by noise, even before I was born. In hearing, my auditory awareness remains saturated with the medium whence it emerged, as is the thing heard. The puzzle is why we, modern people, should have come to think so differently about vision: why it is that when we use our eyes rather than our ears, we should think of ourselves as already completed beings, and of the world as one in which everything has fallen finally into place. It seems that as vision has been co-opted to serve the ends of the modern project of objectification, we have forgotten how things are not just there to be seen but have themselves to be made out from mist or darkness as sculptures of light and shadow. And so we say of a thing or matter that 'it appears', as though the 'it' were already there and waiting to be revealed to our prying eyes, while oblivious to the 'appearing' that must be

done to bring it forth. To say 'appears it', as physicist Henri Bortoft remarks, may be grammatically aberrant, 'but it is better philosophically' (2012, 95–96).

Perhaps the co-option of vision has something to do with the translucence of glass, the ubiquity of mirrors and the conquest of the dark by electric light. As a material, glass is not naturally translucent, and it has taken a massive technological effort to develop procedures to make it so. This effort has been driven by an ideal of perfection according to which the truth of things is to be seen objectively, as through a window, yet without distortion. Perfectly translucent glass both separates us from the object of perception, while yet affording a correct and complete picture. And if glass completes the world as its picture, the mirror completes the self in its own image. We do not need others in whose eyes we can fashion ourselves, when the mirror, as Peter Sloterdijk has it, already provides 'technical means of self-completion' (2011, 205). Finally, with electric light, things emerge from the shadows, as fully formed objects in their own right, given independently of their illumination. But throughout the greater part of human history, illumination through the long hours of darkness came only from the light of the lamp or the fire, glass – if used at all – was uneven and partially opaque, while only the waters of a clear pool could offer reflection. Things looked differently then. The Japanese novelist Junichiro Tanizaki, in his classic essay *In Praise of Shadows*, describes how traditional lacquerware, finished in dark shades of black, brown, or red but decorated with flecks of silver and gold, would come into its own in a room lit not by the sun or electricity but by a single lantern or candle. Dull and garish by day, in the lamplight of an evening the ware would glow. It was made to be seen in the dark (Tanizaki 2011, 21–25).

When we make out sounds from silence, then, are we not doing something very similar to Tanizaki, when he admires lacquerware by candlelight? In the flickering flame, the ware emerges from the shadows. It is appeared, made out. Perhaps we should compare sound, then, to a flame. Now there are two ways of describing a flame, and in drawings these are

often combined. The flame itself is conventionally drawn with curvy lines that rise up from the wick but in no determinate direction. The convention conveys a sense of the liveliness of an apparition that exists only in the process of combustion. Fanning in all directions from a point at the centre of the flame, however, we draw another set of lines. These are absolutely straight, and oriented. In the world the drawing depicts, although we can see the flame, no such lines can be seen. But they are meant to indicate the rays that, invisible in themselves, render visible the surfaces on which they fall. We follow the same convention when we draw the sun as a circle with lines coming out like spokes from the hub of a wheel, or stars as figures with points. Which of these, then, is light: flame or rays? Physics would answer with the latter. Light consists in the rays we cannot see but which afford the sight of things, and radiate in straight lines from a source. But experience tells us otherwise: that light can be seen as plainly as the candle flame; that it does *not* travel in straight lines but curls up and around, much like the smoke of a fire, but along a path orthogonal to the radii that connect the centre of the flame to all points on the periphery.

Beam and pitch

The simple drawing of a candle reveals two quite different ways of thinking about lines of light. There are lines of emission; we call them rays. But there are also lines of combustion. By what term, then, should they be known? I shall call them *beams* (Ingold 2015, 94–100). Nowadays we tend to equate beams with rays, and think of them – like the beams of milled timber that give structural support to buildings – as essentially rectilinear. A projector is otherwise known as a 'beamer'; spotlights and lasers cast beams that can sometimes seem to strake the sky with intersecting lines. It has been supposed that the beam entered the vernacular of English as a translation from the Latin *radius solis*, 'spoke of the sun'. It turns out, however, that this derivation is incorrect. In fact, the luminous beam first appears in Anglo-Saxon sources as the Biblical *columna lucis* – the 'pillar of light' by which, in the Book of Exodus, the Israelites were guided on their way

at night.[8] As such, it is comparable not to straight-cut timber but to the trunk of the living tree, rising from the earth. Though otherwise obsolete, this is a comparison that survives in the common names of tree species such as whitebeam or hornbeam. It is no wonder, then, that the Venerable Bede, writing in the eighth century, used the same word, 'beam', to describe the column of light or fire rising from the body of a saint. For Bede, as the tree-trunk grows from the earth, so light beams from the saintly body as a great flame. And like the trunk, the luminous beam is not straight but twists and turns in response to atmospheric conditions.

8 See the Oxford English Dictionary, entry 'beam, *nr.1*' http://www.oed.com/view/Entry/16505?rskey=QgaBZ0&result=1&isAdvanced=false#eid [Accessed April 8, 2017].

The beam, in short, is a line not of emission but of combustion, and it is in this sense that I shall use the term. What, then, could be its sonic counterpart? I would nominate the word 'pitch', which coincidentally refers to the black, oozy substance released from the roots of the pine tree after it is fired (Ingold 2015, 108). But it is in another of the word's multiple senses that I adopt it here. 'To pitch', among other things, is to cast, toss, or throw. As the tree grows, and as flames rise from the pyre, so – in the ongoing collision of cosmos and affect – sound erupts into the atmosphere formed of their unison. Once again, a clear distinction has to be made between the line of emission, connecting a source and a recipient, by which 'sound' is generally known to physics, and the line of eruption which describes the trajectory of sound as it unfolds in experience. The latter is its pitch. Imagine, for example, the sound of a siren, of the kind that in times of war, warns of an impending air-raid. It is produced by blowing air, with a fan, through an apparatus comprising a rapidly rotating disk within a static cylinder. Both disk and cylinder are punctured with holes that, as they come in and out of alignment, alternately block and release the air flow so as to generate vibrations of greater or lesser frequency, depending on the speed of rotation. These vibrations, conducted through the medium of air, eventually impinge on your ears – maybe some seconds or even minutes later, depending on the distance. On a diagram, you could draw a straight line from generator to ears, measure the distance, and calculate the time it takes for the auditory signal to traverse it.

The line you have drawn is not, however, the same as the pitch-line of the sound itself, as you experience it. For the latter is a line that corresponds with the stretch of your own aural attention as it opens up upon the world. You would likely describe it as having no determinate start or end point, but as rising and swelling, holding for a while at a peak level, and then falling and trailing away. This line describes the trajectory of experienced sound. And the time it takes is the real-time duration of the siren's wail. We make no mistake, then, in identifying the wail as a sound rather than as a pattern *in* the sound. The generator, after all, produces nothing except aerial vibrations. The mistake is rather to confuse the *experience* of sound – that is, its pitch – with the mechanical signals that, along with a well-functioning auditory system, are among the conditions for the experience to occur. This would be the precise equivalent, in the field of aural perception, of confusing beam and ray in the field of vision. The wail of the siren is the analogue of the flame of the candle. As the flame is a beam of light, the wail is a pitch of sound. Both, in our experience, are entirely real. Yet here's the catch: neither the flame nor the siren is truly an *object* of perception. To observe the candle is to see by candlelight; to listen to the siren is to hear by its wail. With both vision and hearing, as Merleau-Ponty pointed out in posthumously published notes, what captures our attention has a way of 'coiling over' so as to inflect the very process of attending (1968, 140).

Becoming ear

It follows that light and sound are at once on the far side and on the hither side of vision and hearing respectively. What I see conditions my own way of seeing, what I hear my own way of hearing. Recall that, for Merleau-Ponty, light and sound are neither 'in here in the head' nor 'out there in the world', neither mental nor physical, but experiential and atmospheric. It is at the very moment when the somatic boundaries between inside and outside dissolve, allowing the space of affect to fill the cosmos – and reciprocally, to be filled by it – that light ignites and sound erupts into our awareness. What happens, then, to eyes and ears? Anatomically

speaking, they are organs firmly cemented in place at the front and sides of the head, primed to receive and respond to photoelectric and vibratory stimuli. But when I open my eyes and ears to the world – when I look, listen, and attend – it seems to me that my head has disappeared. However, my eyes and ears have not, they have rather expanded to pervade the entirety of visual and acoustic space, within which my whole existence is now enveloped. I am, as we say colloquially, 'all eyes' and 'all ears'. To be sure, I can tap with my fingers and confirm that a head is still there. But in the experience of light and sound, where my head is, there's a world! From being a body with eyes it seems that I am becoming eye-body; from being a body with ears I am becoming ear-body. 'An ear body', as sound-performance artist Fabrizio Manco puts it, 'is an inclination to untie and to realise this radical openness, not only through the anatomical hearing ear, but also by becoming one' (Manco 2016, 89). How, then, is it possible to become ear?

For the body to become ear, it has first to be decomposed anatomically, in order that it can then be reconstructed as something like a bundle of affects. This is not a surgical operation, of course, but a switch of perspective from acoustics to the phenomenology of auditory perception, or in other words, from objectification to experience. The ears – and, for that matter, the eyes as well – are thenceforth no longer the *organs* of a body but the affective dispositions of what philosopher Gilles Deleuze, along with his collaborator, the psychoanalyst Félix Guattari, calls a 'body without organs' (2004, 165–184). The question of navigation, then, is one of how such a body can find its way around. According to Manco, the ear-body achieves this by tracing what he calls 'earlines'. If the cast of sound is its pitch, the earline is the stretch of attention that follows it like an elastic thread. The line can be inscribed on paper by drawing, or on the ground by walking, but the stretch itself is aerial (Manco 2010, 102). To get a sense of it, take a sheet of paper and crumple it up into a tight ball; then spread it out again. It will reveal a dense and irregular mesh of folds and creases, not unlike the surface of the ocean ruffled by the wind. It is a characteristic of folds and creases that they

emerge from the surfaces in which they are formed, but never part from them. Where the paper or the ocean is crumpled on the surface, the air is crumpled in its volume. The 'crumpledness' of the volume is tantamount to its noise. And within it, every crease, every fold, affords a line that can potentially be followed. Just like the crease in the paper or the ruffle in the sea-surface, however, the line is *in* the noise, and never parts from it.

This has an important corollary, namely, that tracing an earline is an effort of continuous differentiation.[9] The theatre scholar George Home-Cook describes thus his efforts to 'hear himself think' against the background noise of children playing next door: 'it is to listen out intently for my thoughts as they momentarily and haphazardly pop into view within this sonic barrage' (2015, 24). What is this 'listening out'? It is not about search and retrieval. To hear something, rather than nothing, is not to come away with some material substance or object found. But nor should this imply that sound is immaterial. It is rather *in*-material, just as grain, for example, is *in*-wood, crease *in*-sheet, and path *in*-ground. Earlines are traced in the grains, creases, and pathways of crumpled noise. They are no more and no less than lines of difference. To hear something is always to cut a fine line between the indifference of silence and of noise – or of what Deleuze has called 'black nothingness' and 'white nothingness' (1994, 28). I have referred to this process of cutting from within, quite generally, as one of *interstitial differentiation*. By this I mean to oppose it to the external accretion by which assemblies are formed from initially discrete and self-contained elements (Ingold 2017, 13). It may be that the energetic sources of sound can be added one to another, as were the voices of neighbouring children for Home-Cook. But to attend to any particular sound or voice is not to set it apart by subtraction but to cut along its line, as the carpenter cuts along the grain, the seamstress along the crease, or the walker along the path.

9
In a study of the ceremonial healing songs of Temiar people in Malaysia, anthropologist Marina Roseman explains how, in performance, 'Temiars employ a variety of tools that "beg the difference" between sound and silence, light and darkness, motion and stillness, one body position and another' (2008, 62). Perhaps all listening is 'begging difference' in this sense.

This brings us back, at length, to the question with which I began. How can we tell noise from silence, white from black? With a clearer understanding of what sound is, we have some hope of answering the question. We can do so by returning to the comparison with light, but this time with regard to a phenomenon of experience that I have not yet touched upon, namely colour. Many people, gifted with a synaesthetic sensibility, will readily associate colour with the quality of experienced sound, generally known as its timbre. Indeed, the association is so well-established that in the German language, for example, the word for timbre, *Klangfarbe*, literally means 'sound-colour'. The philosopher Jean-Luc Nancy has observed that there is 'no pitch … without timbre (just as there is no line or surface without colour)' (2007, 39–40). How come, then, that not only can pitch be specified in the notational conventions of classical music, on the stave score, quite independently of timbre, but also that the surface which – more than any other – is iconic of modernity, namely the transparent pane, mirror, or screen, is perfectly colourless? Pitch, it seems, has been abstracted from the cast of sound, and colour from illumination, only to be aligned on a scale of quantitative variation which allows the properties of energetic emissions to be objectively specified without regard to the qualities or intensities of sonorous or luminous experience induced in those with ears to hear or eyes to see. In effect, both pitch and colour have been spectralised: the one laid out on a spectrum of vibrational frequencies, the other on a spectrum of wavelengths (Ingold 2015, 111).

Analysts have struggled to find terms, including 'brightness', 'saturation', and 'value', to capture the ordinal qualities of light that are left once colour has been siphoned off. None, however, exhausts the inherent lustre, say, of Japanese lacquerware. Nor can their equivalents in the analysis of sound, such as 'amplitude' or 'tone', exhaust the qualities of timbre. At the root of the problem is the elision of beam with ray, in the case of light, and – in the case of sound – of the line of pitch with the line of emission. At the turn of the eighteenth

century, it caused Johann Wolfgang von Goethe, scientist-poet and pioneer of Romanticism, to launch a celebrated attack on the mechanical optics of Isaac Newton.[10] For Newton, mathematician and physicist to the core, light meant rays. And rays, when differentially refracted by means of a prism, would yield up all the colours of the rainbow, from red to violet. Recombined, they would merge into 'colourless' white. Colour, then, was strictly a property of rays, and as such, given quite independently of our experience of it. But Goethe would have none of this. For him, light was a phenomenon of experience – an affective intermingling of our own awareness with the turbulence and pulsations of the medium. It was the flame of the candle, not its rays, and it lit up the world, as do the flames of a fire, in the combustion of materials. As with the blaze of a wood-fire, light at its most intense is white, grading off through yellow, red, and blue to the black of cold charcoal or of the pitch that oozes from charred roots. Thus light acts on matter as fire on wood, generating all the colours in the process, on a scale from white to black.

10 Goethe's *Theory of Colours* (2006) was first published in 1810.

Now, this is a scale not of quantitative variation, as would nowadays be measured in terms of wavelength, but a qualitative scale of affective intensity – of degrees of difference rather than differences of degree (Ingold 2015, 103). And only on such a scale can we register the contrast between black and white, or distinguish darker colours from lighter ones. This is why Gibson, as will be recalled, had such a problem with light and darkness. If you see not light itself but only patterns in the light, then how can you tell day from night? The shifting shadows cast by the sun in its diurnal traverse of the sky give us information about the features on which the light falls, which at night might be picked out in the moonlight or by the beam of a torch. But how can we account for the different experience of sunlight, moonlight, and torchlight? Gibson attempted to deal with the problem by distinguishing between 'chromatic colour' (the hues of the spectrum) and 'achromatic colour' (the variation from black through grey to white) (1979, 31). Ecologically speaking, he argued, patterns of chromatic colour are picked up along with other visual information specifying the invariant properties of surface texture in the

environment. But achromatic colour – literally 'colourless colour' – remained an enigma, as did the colour of firelight. Considered ecologically, Gibson tells us, a 'fire with flames … consists of complex motions and deformations' (ibid, 98) which bring about modulations in the surface texture of the burning material and ultimately reduce solid surfaces to ash. To be sure, in the course of its fiery transformation, the material changes colour, and this is ecologically relevant. But what has happened to the flames? The fire burns, but the flames, in our perception, have gone out.

Now, what goes for colour also goes for pitch, and the problem is the same. Just as Gibson distinguished chromatic and achromatic colour, we could likewise distinguish 'pitched pitch' from 'pitchless pitch', but the results would be equally paradoxical. Pitched pitch would be the counterpart of spectral hue, and would vary from high to low, depending on the vibrational frequency of the signal.[11] Patterns of pitched pitch, picked up by the moving and attentive observer, could reveal relevant objects and events in the environment. We can use these patterns to find our way around. However, pitchless pitch, the cast of sound itself, remains unaccounted for. Of course, we have a word for it, namely, timbre. But an acoustics that remains limited to the detection of invariance in pitch patterns has no place for the experience of timbre. The wail of the siren, the clang of the bell, the honk of the horn, the buzz of the insect, the whoosh of the wind, the thump of the beating heart – all these sounds, which have inspired such a rich vein of onomatopoeia – would be lost to perception. Each would be the sonic equivalent of the vanishing flame or beam. And the solution? It is to undo the division between pitch and timbre, to bring them together again into the fullness of phenomenal experience. This is the precise equivalent, in the field of sound, of the re-unison of colour and lustre in the field of light. Only then can we understand how, in life, we are consumed by noise – as wood by fire – and how, starting from the blooming, buzzing confusion of the womb, and following with our earlines along the ways of the world, we end up with the silence from which, like the number zero, everything comes.

11 This is how pitch is defined in a textbook on the physics of music that I have had on my shelf for the past fifty years. According to its author, Alexander Wood, pitch is 'the characteristic of a sound by virtue of which we describe it as "high" or "low"', or more exactly, 'the subjective quality of a sound that determines its position in the musical scale' (Wood 1944, 42).

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Sprache der zeichnenden Hand

Falling Darts, a Lost Submarine, and a Blind Man.

Notes on the Media History of Navigating through Noise

Christian Kassung

60.

Noise is the medium of sound

One could certainly say that noise has always existed. It is very much in this sense that Jochen Hörisch starts his history of media with the physicists' Big Bang:

'In the beginning was the sound. And this sound was so tremendous that we are able to hear its echo until now. The constant noise, even heard by a postmodern ear [...] in the loneliest place on the quietest winter night, is explained by astrophysicists as the echo of the Big Bang' (Hörisch 2004, 23).[1]

[1] Translation provided by the author.

This eternal noise doesn't seem to have any meaning apart from that it evokes the beginning of everything, the eternal chaos of a time when time still didn't exist. However, in order to recall such memories, one doesn't need to look for an abandoned place on a cold winter night. It can help to use a medium, a conch shell. The ancient philosopher Aristotle describes this media technology with all of its consequences:

'Further, we have evidence whether we hear or not, according as there is or is not always a ringing sound in the ears, as in a horn: for the air imprisoned there is always moving with a proper motion of its own. But sound is something of external origin and is not native to the ear. And this is why it is said that we hear by means of what is empty and resonant, because that by which we hear has air confined with it' (Aristotle 1907, 85 [420a15–19]).

According to Aristotle, the ringing sound stops when somebody makes a sound. Hence, there are two things, the noise and the sound. The noise is the medium and the sound is the message. Or, to put it the other way around: noise is the medium of sound.

Within this epistemic constellation, noise seems to be a neutral medium in itself that carries no information at all. The medium and the message are two things. It is well known that this concept of noise has radically changed in the course

of the 20th century with a long and prominent series of scholars such as Claude Shannon, Marshall McLuhan, Michel Serres, and Friedrich Kittler. The question I would like to pose in this context is the role of physics and media technologies. Noise in the Aristotelian sense is something that cannot be measured *per definitionem* because noise enables things to become measurable, communicable or meaningful. As a medium, noise is outside the realm of quantification. But for physics, phenomena need to be measurable. Hence, noise becomes part of physical knowledge in the moment of its measurability.

Noise is a media effect

Thus, turning noise into a measurable phenomenon was, first of all, a media effect. This media effect took place between the sites of the most advanced contemporary physics and electrical engineering, namely, the University of Berlin and the electrical engineering company Siemens & Halske. After having earned his Ph.D. in relativistic dynamics under Max Planck in 1912 and beginning his habilitation at the University of Berlin, the German physicist Walter Schottky switched to industry, working as an electrical engineer in the weak current laboratories of Siemens & Halske (Serchinger 2008). Only a few years before, the cathode ray tube had undergone a significant transformation from a measuring into an amplification device. The Siemens laboratories were therefore positioned in the centre of the emerging field of electronics, later transforming everyday life with media such as the telephone, radio, and television. All of these emerging technologies relied on the problem of amplifying weak electrical currents by controlling other currents. In 1912, Siemens & Halske purchased the patent rights to the so-called Lieben-Röhre in order to develop this new concept further into a reliable technology (von Lieben 1906).

In particular, the army needed reliable telecommunications. It is one of the great ironies of history that the louder the sound of the cannons, the more pressing was the need for turning inaudible signals into audible information. We may not need

to go as far as the German media historian Friedrich Kittler: 'A world war, the first of its kind, had to break out to facilitate the switch from Poulsen's arc transmission to Lieben or De Forest's tube-type technology and the mass production of Fessenden's experimental procedure. It was not only in Germany, where the signal corps created in 1911 went to war with 550 officers and 5,800 men but returned with 4,831 officers and 185,000 men, that the development of amplifier tubes was given the highest priority. [...] But that's the way it goes. The entertainment industry is, in any conceivable sense of the word, an abuse of army equipment' (Kittler 1999, 95–97).

But without any doubt, Walter Schottky was one of those physicists who found ideal working conditions in Lab K at Wernerwerk for bringing together the physical theory and technical application of vacuum tubes. This leads me to my central thesis, which is that in the historical context of this boundary-work, a new concept of noise as a media effect evolved.[2] To better understand and further develop this thesis, we have to go deeper into the publications of Walter Schottky and his colleagues.

2 For the concept of boundary-work see Gieryn (1999).

At the end of World War I, in 1918, Walter Schottky wrote:

'By connecting a series of hot-cathode amplifying tubes, it has become possible during the last years to make alternating currents of extremely low amplitude perceivable and measurable. This gave sudden support to many technical problems, but it also seems that a new field of research has opened up to scientists; the amplifying circuits will certainly have the same significance for electrical experiments as the microscope in optics' (Schottky 1918, 541).[3]

3 Translation of all quotes from this text provided by the author.

In this quote, it is particularly significant that Schottky compares the amplifier tube with the microscope. Our reality is constituted by media, and we cannot separate our knowledge from the media by which it is produced. It is, to put it in the Kittlerian way of thinking, not man that produces media but media that determine mankind. But what knowledge is produced by these new media?

The big promise of all new media is to cross the limits of our own natural media or senses and advance up to the elements and structures of the real. The pioneers of the vacuum tube also thought that it could be possible to amplify even the tiniest electrical signal - provided perfect isolation of the apparatus, etc. What Schottky wanted to show was that there was a 'certain insurmountable threshold' for the amplification of electrical signals by vacuum tubes (Schottky 1918, 541). One of the reasons for this fundamental threshold is the quantization of the electron's elementary charge (the "Schroteffekt" or small-shot effect). A second reason is the thermal movement proportional to kT of the particles ("Widerstandsrauschen" or Johnson-Nyquist noise). In other words, at the end of World War I, noise became a fundamental property of all matter because Schottky traced his experimental observations with amplifying tubes to the principles of quantum mechanics, which he learned at Planck's Physikalisches Institut am Reichstagsufer in Berlin.

Even if all external disturbances are eliminated - or at least ignored - then some noise is audible in the telephone, radio, sonar or any other medium because the mean thermal energy kT produces electrical oscillations (ibid, 542). Below this energy or power limit on the order of 10—17—10—15 watts, no amplification of signals is possible (ibid, 545 & 563). Because a signal power of this order is accessible to contemporary amplification technologies, these noise effects are definitely noticeable, on the one hand, and they prevent the ability to render audible signals below this threshold, on the other:

'Just because of the atomistic structure of electricity, the vacuum tube acts as an oscillation generator to a certain degree' (Schottky 1918, 564).

This means that only at the surface of the sound is the noise of a vacuum tube and conch shell identical. What we hear *is* identical:

'When these irregularities are sufficiently amplified by other vacuum tubes to be perceivable by means of a telephone

receiver, they give rise to a continual sound with no definite pitch, like that usually associated with the conch shell, or like the faint sound that is heard when the hand is cupped to the ear' (Johnson 1925, 71).

But from an epistemological perspective, the cathode and the conch belong to totally different knowledge systems. The noise in the conch shell is only noise for our ears. It is possible to filter the signal and to decide clearly if there is a meaningful signal or not. In the case of the vacuum tube, the "inherent" noise is not an "apparent" one - because it is produced by elementary particles - but it is fundamental in the sense that it is impossible to develop a filter or amplification that goes deeper than the noise level (Johnson 1925, 83 & Hartmann 1921, 74).[4]

The Swedish-born electronic engineer Harry Nyquist at Bell Labs was the first to be able to give a full and valid explanation of thermal noise. His renowned formula

$$\overline{u_r^2} = 4k_BTR\Delta f$$

was based on Johnson's work and on a series of thought experiments. This is, indeed, thermodynamics, and it is also quantum mechanics. Because the noise level cannot rise infinitely with the frequency, Nyquist introduced a crop factor (Nyquist 1928, 113):

$$\overline{u_r^2} = 4Rhf\frac{1}{e^{\frac{hf}{kT}}-1}\Delta f$$

Nyquist didn't comment on this step and he gave no reasoning. With this factor, Nyquist's oscillator became a one-dimensional model of Max Planck's solution of the so-called black-body radiator, which led to a totally new physics of quantum mechanics (Planck 1901, 561). Thus, becoming explicable through quantum mechanics, the epistemology of noise effects in vacuum tubes changed dramatically. The later Nobel Prize winner Richard P. Feynman carried the formalization of noise to the extreme, where no physical device is needed anymore:[5]

4
Because Schottky made a mistake in his calculations, he was unable to pursue his initial assumption of mutually independent elementary particles and hence a statistical approach. John B. Johnson, born in 1887 in Göteborg, was able to correct this error and get a good approximation of the elementary charge of the electron.

5
For a much broader contextualization of the noise concept see Dörfel/Hoffmann (2005).

'However, we may replace the real circuit having an honest, true physical resistor which is making noise, by an artificial circuit which contains a little generator that is going to *represent* the noise, and now the resistor is otherwise ideal - no noise comes from it. All the noise is in the artificial generator' (Feynman 1977, 41-1).

While Aristotle could argue on the basis of specific particles behaving in a classical manner with an impact and movement, Schottky's starting point is a large number of indistinguishable particles with different statistically distributed energies. Noise has become a statistical and thus fundamental phenomenon as a consequence of the quantification of electrical charge. It has turned from something subjectively annoying into something objectively significant.

The sound of flechettes

On July 17, 1816, while Schottky and Hartmann were sitting in Lab K. at Wernerwerk in Berlin, the German soldier and author Ernst Jünger wrote in his diary: 'Then our artillery began to a great extent and delivered an infernal concert. Gradually, the affair subsided' (Jünger 2010, 155).[6] World War I entailed static warfare, where German soldiers lived for weeks and months in the same trench, while the French and British artillery performed a day-long barrage fire. Though strategically almost useless, the barrage fire had an enormous impact on the soldiers' minds: the enemy could be anywhere at any time. 'It was a noise like doomsday' (ibid, 127).[7] The same scene appears in 'Storm of Steel' in a much more detailed form:

'A curtain of flames was let down, followed by a sudden impetuous tumult such as was never heard, a raging thunder that swallowed up the reports even of the heaviest guns in its tremendous reverberations and made the earth tremble. This gigantic roar of annihilation from countless guns behind us was so terrific that, compared with it, all preceding battles were child's-play' (Jünger 1996, 250).

6
Translation of all quotes from this text provided by the author.

7
Also see Paul (2013, 80–87).

One cannot close the ears, and even in times of quietness the soldiers were aware of revealing sounds.

Now, what was actually heard by the soldiers? Michael Salewski describes the soundscape of World War I as follows:

'The actual, real noise of battle is the firing of everything that is able to shoot and to explode; a wide range of sharp, high- and low-frequency sounds superimposes the battleground with a dynamic-monotone cacophony and lets the front "rumble"' (Salewski 2009, 191).[8]

8
Translation provided by the author.

Hence, three things constitute the sound of the war: first, the sheer noise that means an extremely high amplitude of acoustic waves; second, the monotony of the different noises - a cacophony of sounds; and third, some sharp and very dynamic sounds (Volmar 2014). My argument is that as long as the soldier only hears the drumfire, no structured space is constituted. On the contrary, the drumfire is a non-space, a ubiquity of danger, threat, and fear. Hence, to survive means to transform this non-space into a structured soundscape - a space where certain weapons with specific purposes belong to different locations in this omnipresent war. And this transformation involves giving the noise an epistemic significance. Ernst Jünger describes the importance of this ability to discern different sounds of the battlefield:

'When you've spent some time in the field, you get to know many strange sounds. Experience is crucial, you learn to distinguish who has fired a shot, in which direction, what kind of projectile it was, etc. […] Paff! Hulululululu […] Udja – Udja – Udja – Udja – Udja – udja –uja – Udja – Udja – Udja – clack – boom!!!' (Jünger 2010, 75–78).

This argument brings us back to the question of media technologies and how to discern, store, symbolize, and transmit noise. Shortly after Friedrich Kittler published his *Gramophone, Film, Typewriter* in 1987, some scholars continued his media archaeologist approach in other fields of literature. One of the most prominent authors who was interpreted

again and again in this period of dramatic change in the German humanities was Robert Musil (see Hofmann 1997, Breuer/Kassung 2000).

Like Ernst Jünger, Musil was a soldier in World War I. He was stationed at the Isonzo Front, where Austro-Hungarian and Italian armies fought a series of 22 battles. On September 22, 1915, he was barely missed by a flechette that was released by an Italian aircraft. In his famous short story "The Blackbird", he describes this scene as follows:

'At that instant I heard a distant ringing drawing closer to my ecstatically upturned face. Of course, it could also have happened the other way around, that I first heard the ringing and only then became conscious of the impending danger; but I knew immediately: It's an aerial dart. These were pointed iron rods no thicker than a pencil lead that planes dropped from above in those days. And if they struck you in the skull, they came out through the soles of your feet, but they didn't hit very often, and so were soon discarded. And though this was my first aerial dart - bombs and machine-gun fire sound altogether different - I knew right away what it was. I was excited, and a second later I already felt that strange, unlikely intuition: It's going to hit!' (Musil 2006, 157–158).

←
The War Illustrated Flechette (Hammerton 1915, 387).

The main question that arises from this quote is: how does the narrator know that the flechette is going to hit him? Indeed, we can answer this question within the context of our contemporary knowledge of acoustics, because Musil had studied mechanical engineering in Stuttgart and psychology under Carl Stumpf in Berlin, so this and other texts from him operate precisely at the borders of this knowledge.

'It was a shrill, singing, solitary, high-pitched tone, like the ringing rim of a glass, but there was something unreal about

it. You've never heard anything like it before, I said to myself. And this tone was directed at me; [...] Meanwhile, the sound from above became ever more tangible; it swelled and loomed dangerously close. [...] And suddenly the singing became an earthly sound, ten, a hundred feet above us and it died. He - it - was here. Right here in our midst, but closer to me, something that had gone silent and been swallowed up by the earth, had exploded into an unreal hush' (ibid, 159-160).

The first statement of this quote is that the narrator *knows* the direction of the object making a sound, the flechette. The second statement addresses the distance between the narrator and the object. And in the third text passage, the narrator describes the ending point of the aerial dart's movement only a few metres away from his own position. It is thus clear that it is not only possible to discern the quality of a signal (I will return to this issue in the last part of this paper), but also to estimate the trajectory of a signal. Noise is, it its very essence, a spatial phenomenon. And because sound propagates faster than the shell, it is possible to hear - to some extent - one's own future.

In the spring of 1915, two other scholars working under Carl Stumpf - Erich M. von Hornbostel and Max Wertheimer - figured out that the different run-time between the two signals to the left and to the right ear enables directional hearing or "Richtungshören" (Hornborstel/Wertheimer 1920, 391–393).[9] Depending on the angle between the noise source and median plane of the head, the signal has a longer or shorter path length. Two things are essential for Hornbostel's and Wertheimer's experiments. Firstly, noise can be better localized than sound. Or, as Hornbostel puts it as clearly as possible:

'Directional perception works better for noise than for sounds or simple tones. [...] The sharper characteristics of noises make them appear more concrete and easier to locate' (Hornbostel 1926a, 603 & 612).

Hence, spatial acoustics do not begin with sound or music.

9 The main argument against phase theory is that it can't explain the "Richtungshören" of noise but only of sounds, see Hornbostel (1926a, 612).

They begin with the ability to spatialise noise (Berz 1990).

Secondly, the goal of Hornbostel's and Wertheimer's experiments was not only to understand human hearing but also - and maybe foremost - to enhance it using media technologies:

'The dependence of perceived directionality on the time delay with which a sound pressure wave hits both ears leads us to the idea that acoustic localisation could be improved by increasing the time delay artificially. This can be achieved if the sound receivers - the microphone or ear trumpet - are placed at a greater distance from one other (directional listener)' (Hornbostel/Wertheimer 1920, 389).

In this respect, we are back in World War I. The soldier is transformed, in the Kittlerian sense, into a listening machine, merged with cutting-edge media technologies: 'We know all the noises of the night. [...] We are nothing but ear, a tensed eardrum' (Jünger 1922, 104).[10]

10 Translation provided by the author.

The reassessment of noise on the battlefield outlined here equates to the process of epistemic revaluation by Walter Schottky. Navigating noise in the context of World War I means being able to estimate the spatial dimension of the drumfire. Extending Hornbostel's argument that noise is more fundamental for directional hearing than sound means that noise is produced by media. It is contemporary media technology in conjunction with experimental psychology that makes soldiers able to navigate noise.

To hear and to be audible

Thus far we have mainly discussed the period of World War I without clarifying the difference between sound and noise. I would now like to move on to a second war scene that allows me to discuss this issue. On Monday, August 14th of the year 2000, the staff members of the Norwegian Seismic Array in Kjeller near Oslo went to work as usual. During the weekend, the measuring stations were unstaffed, so nobody had yet noticed the registration of a strange incident two days before

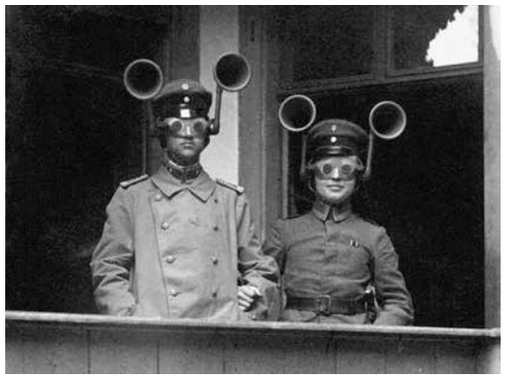
at the ARCES station in Karasjok in northern Norway. The north-eastern coast of Norway has a high concentration of seismographic stations for a very simple reason: not very far away is the Russian archipelago of Novaya Zemlya, a place where both radioactive waste is stored and atomic bomb tests were periodically carried out from 1957. Furthermore, many decommissioned nuclear submarines were dumped off the archipelago. Ever since the Chernobyl disaster, the world - and especially the Norwegians - have been aware of the risk of nuclear accidents. In any case, the Norwegians in Karasjok had their ears very close to the looming dangers of the Barents Sea.

The first, automatic analysis of the data from Karasjok revealed the following:

'The larger explosion [...] observed at several stations occurred at 07.30.42 GMT at an estimated location of 69 degrees 38 minutes North, 37 degrees 19 minutes East. This explosion had a magnitude of about 3.5 on the Richter scale, corresponding to about 1–2 tons TNT detonated in water. The smaller seismic event with a magnitude of about 1.5 was recorded from the same location 2 minutes 15 seconds earlier. This event was only observed at the small aperture ARCES array. The observed waveforms, onset times and backazimuths from ARCES suggest the same location as for the second larger event' (NORSAR 2000, 15).

The larger explosion had also been detected by many other stations. Only the stations in northern Norway had registered the much smaller event at the same coordinates a good two minutes earlier. Hence, the NORSAR staff assumed that both events had the same origin.

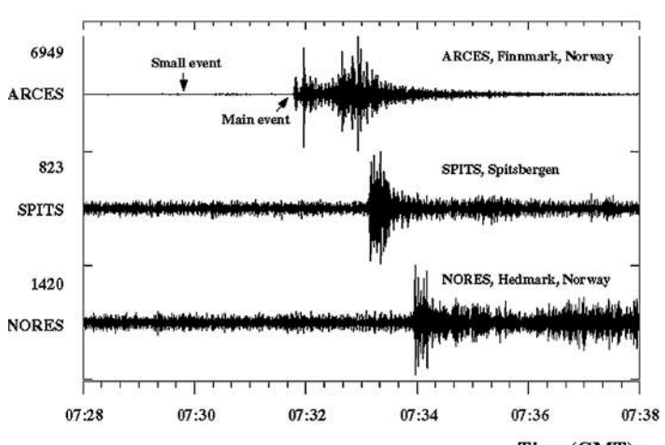
In any event, while the acoustic traces of an unusual event in the Barents Sea were lying on the table of the scientists on August 14th, the official reporting had just started. The scientists thus learned from the media that the most advanced Oscar-class submarine, the *Kursk*, had been severely damaged during one of the largest naval exercises of Russia's



←
The War Illustrated German sound location, 1917, in: www.douglas-self.com/MUSEUM/COMMS/ear/ear.htm.

Northern Fleet in more than a decade. The submarine sank due to its severe damage, and the survival of the crew was at stake. As a potential cause of the accident, Russian reports indicated (politically correctly) a collision - even months after the accident. The Russian press was determined to keep all sensible information secret, while the Norwegian seismographic data were absolutely open and accessible to every seismologist via the internet. The television pictures could only document the rescue efforts and, much later, the massive effects of the explosion(s). Unaffected by this, the seismographic recordings left a difficult-to-read but all the more precise trail leading to the cause of the accident. The question, then, is how one can read such acoustic traces.[11]

11
I will leave out the history of the recording media here that I have covered elsewhere, see Kassung (2009).



←
NORSAR Record-NORSAR recordings (2000, 15, fig. 3).

Looking once again at the seismographic recordings of NORSAR, we can immediately state that there is no periodical oscillation, no continuous curve and no significant pattern. In brief: we see a noise and no directly readable signal.

'A sound wave cannot be characterised by isolating any part of its progression but solely by its progression as a whole. And if a single momentary state of oscillation, a "phase", recurs, it is embedded in a different progression, and thus each phase is different' (Hornbostel 1926a, 612).

In the sense of the physiologists of World War I, the explosion(s) of the *Kursk* were perfect acoustic events. Because the amount of released energy was so high and the transmission conditions underwater were highly efficient, the produced noise contained such a huge amount of information that it was possible to successively isolate the most probable source.

Now, what do we actually *see*? In principle, a seismometer consists of a weight attached by springs to its housing. When the housing moves in a certain direction, the weight tends to resist this movement due to its inertia. Hence, the relative motion between the mass and the housing is a measure of the degree of seismic activity. Modern instruments can measure and record seismic motions from some fraction of a second up to 500 Hz in a vertical and horizontal direction. A seismogram typically consists of three curves corresponding to the energy of the movement perpendicular (z axis) and parallel (x and y axis) to the surface and as a function of time. Two conclusions can be drawn from this very short technical overview. Firstly, seismology, as in the case of World War I, is a form of directional hearing. Because there are at least two signals from different positions or different angles, it is possible to calculate their common source. In the case of the *Kursk* this was of the highest importance because only a more or less precise localization of the accident allowed for a promising rescue action. Secondly, the recording does not differ fundamentally from those that 19th-century scientists used to understand the function of the ear and to implement this knowledge in media technologies such as the telephone or gramophone.

We can now take a closer look at the seismic recording of the *Kursk* accident. When there is no significant event, we see the typical noise of a microseism. Any natural or technical event, such as waves, ships, wind, animals and so forth, leaves an acoustic footprint and is summed up in the signal's background noise. The signal of the accident clearly stands above this noise floor. The first wiggles are the P waves, corresponding to longitudinal compressions of the continuum which, in this case, is the sea, of course. These pressure or primary waves have the highest velocity and therefore occur as the first signals of the recording. Usually bigger than the P waves are the S, second, or transversal shear waves with a lower frequency, which means that their curve is more spread out.[12] The ratio between P and S wave energy is characteristic of the nature of the event. As Kooper et al. emphasise, 'explosions produce a higher ratio of *P* to *S* wave energy, especially at higher frequencies, which is inconsistent with the high level of *Sn* and *Lg*' (Kooper et al. 2001, 45). Consequently, one has to take an even closer look at the data from what is known as spectral analysis. This means that the power or amplitude of a signal in an infinite frequency interval is described as a continuous distribution over the frequency. The mathematics behind this form of data representation is the Fourier analysis.

12 There are also other wave propagation mechanisms, such as the L or Rayleigh-Lamb waves, which are of minor importance for our discussion (Shearer 2009, 49). For the history of this nomenclature, see von dem Borne (1903, 441).

In the case of the *Kursk* event, Kooper et al. discussed the amplitude spectra of several regional stations (ibid, 46, figure 4). The figure shows the P spectra of five stations from (nearly) 0 to 15 Hz. One can clearly distinguish four adjacent troughs separated by ≈ 1,45 Hz (Savage/Helmberger 2001). Because all distant stations record the same scalloped spectral pattern, it must be a characteristic of the source event. What kind of event – an earthquake, an explosion, or an impact with the sea floor - produces such a signature? Kooper et al. gave the following answer:

'The most definitive seismic evidence that the main *Kursk* event was dominated by an explosion source is the observation of a 'bubble pulse'. Explosions that occur underwater generate a bubble of hot gases that quickly rises to the surface.

This gas bubble oscillates in response to the confining hydrostatic pressure, and this oscillation has a dominant frequency that is related to the type of explosive, the yield of the explosive, and the depth of detonation' (Kooper et al. 2001, 45).

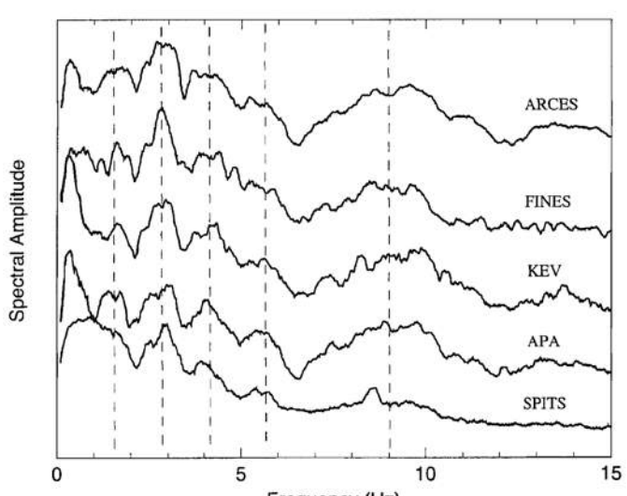
The earth murmurs. What is nature, what is technology, and what is culture turns into a cacophony of different disturbances, messages, and secrets (Hornbostel 1926b, 704). We can neither completely decode nor totally control this assemblage of sounds. Nevertheless, this is exactly what our ear is trying to do at all times: Fourier analysis.

'Now, if signals were wholly periodic, if they were music instead of noise or prose instead of poetry, it would be possible to formalize their rules:

$$s(t) = \frac{a(0)}{2} + \sum_{f=1}^{\infty} a(f)\cos(ft) + b(f)\sin(ft).$$

Processing nonperiodic functions, however, is more delicate; unfortunately, it is also of greater practical relevance. As opposed to the *Iliad* or the Ten Commandments, information requires 'that something unknown is transmitted'' (Kittler 2017, 12).

→
Amplitude spectra of the NORSAR recordings (Kooper et al. 2001, 46).



Even though culture tends to use periodical oscillations in the form of letters, tones, (rational) numbers, codes, and so forth, noise conceals the unknown, the new, the unexpected, the uncanny. Seismologists heard the collapse of the Twin Towers in 2001, they register meteorite impacts and car bombs as well as the noise of traffic, mining, and waterfalls. Hence, navigating noise could mean learning about the unseen from the unheard - especially if the events are as singular as in the case of the *Kursk* disaster. And because the sound of the explosion is so complex, it transmits a high amount of information. Media technologies such as the seismometer produce the noise that is or can be reconstructed as the tragic explosion of a Russian submarine.

'Hence, the question of whether something is a message or simply noise [...] will be answered by replacing the decision itself with a theory and practice of noise filtering' (Siegert 1993, 194).[13]

13
Translation provided by the author.

It is this medial *a priori* that constitutes noise in the epistemic sense of Schottky and his successors.

Navigating with echos

Submarines are invisible. The history of rendering them visible traces back either to the natural philosophy of Descartes or to the French physicist Paul Langevin and thus, once again, to the context of World War I. Going back to the early modern period, one could say that 'from Descartes to Berkeley to Diderot, vision is conceived in terms of analogies to the senses of touch' (Crary 1992, 59). It is the metaphor of the blind man constituting an epistemology of a tactile geometry in which vision operates by touching the outer world with two more or less material sticks. The crucial point here is that there are two sticks, which explains why humans have two eyes and two ears (Mach 1903, 83–84 & Hornbostel 1923, 64). Or, as Descartes already put it in his 1677 work published posthumously, "Le Monde ou Traité de l'Homme":

'Notice also that if two hands *f* and *g* each hold sticks *i* and

h with which they touch the object *K*, then even though the soul is otherwise ignorant of the length of the sticks, nevertheless, because it can tell the distance between the points *f* and *g*, and the sizes of the angles *fgh* and *gfi*, it will be able to tell, as if by a natural geometry, where the object *K* is' (Descartes 2004, 133-134).

Hence, once again, we can capture an extremely close relationship between seeing and hearing, linked by an active and bidirectional signal process. This leads us to the central epistemic turn, that even though sound or light normally comes from the seen or heard object, we can use a light beam or sound wave to scan the outer world. Or, as Erich M. von Hornbostel puts it: 'Hearing ranks between vision and the sense of touch in this sequence, standing particularly close to the latter in many ways' (Hornbostel 1926b, 701).

→
Descartes' Model
Descartes' model of vision (2004, 134, fig. 46).

These brief remarks on the epistemology of vision allow us to jump directly back into the context of World War I. Together with Constantin Chilowsky, a Russian physicist living in Switzerland, the French professor for physics at the Collège de France, Paul Langevin, filed two patents disclosing a media technology for rendering submarines visible by ultrasound. Sonar technology operates strictly along the metaphor of the blindman's stick: an acoustic signal is sent out by the subject and reflected by some object. This reflection process modifies the signal in at least three respects. The first effect is the same as von Hornbostel's and Wertheimer's directional hearing, apart from the fact that there is only one ear. The acoustic signal needs a certain amount of time to propagate through

the water to the enemy submarine and back to the sender. By measuring this period of time, it is possible to calculate the distance between the two submarines. What is interesting in our context is the fact that the higher the frequency of the sonar signal, the more it behaves like an electric torch:

'The ultra-sonorous beam thus obtained is similar to the luminous beam of a search-light and can be used, either to produce signals or to detect the presence of obstacles by the observation of the diffused or reflected radiation. [...] Oscillations of greater frequency are too rapidly absorbed in water owing to its viscosity and slower oscillations would give too open beams' (Chilowsky/Langevin 1923, 1).[14]

It now appears as if navigating noise, in the case of sonar, means focusing the acoustic beam as sharply as possible in order to ensure the most precise distance measurement. But the quote refers to two media effects, namely, reflection and diffusion. Diffusion, or scattering, is an effect that naturally depends on the structure of the reflecting object, but also on the frequency of the signal. When an acoustic wave strikes an obstacle, then according to the Huyghens-Fresnel principle every point of the obstacle becomes the source of a new spherical wave. The sum of these waves forms the new, diffracted wave. This means that, in the case of an obstacle that is smaller than the wavelength of the source signal, the wave travels around the obstacle. Or, as von Hornbostel puts it:

'To my left behind the wall there is barking. I know from experience that it is a dog. I can hear the barking to my left despite the wall in front of me. I would hear it even if I could never go behind the wall to have a look, if I had never seen a dog before nor heard one barking' (Hornbostel 1926a, 602).

If we allow the signal to scatter, if we do not use a clear tone with a high frequency, we can practically hear around the corner. Navigating noise in this case means that the ear is able to hear things that are hidden from our eyes.

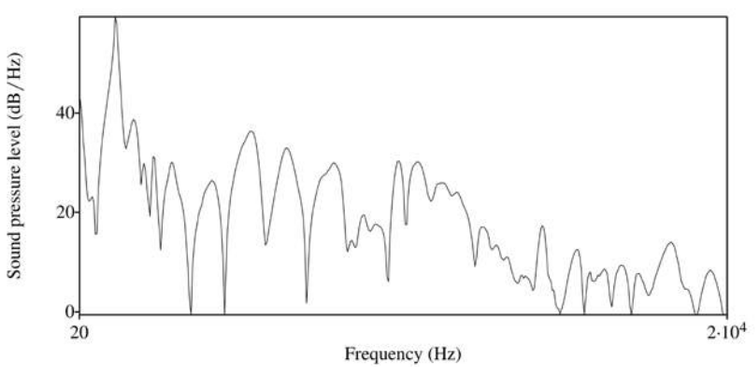
This quote by von Hornbostel also brings me to the last of

14
In their patent letter, Chilowsky and Langevin give only little attention to the problem of receiving and processing the signals. But it is very interesting to note that, on the one side, the signal's amplification with vacuum tubes is mentioned and, on the other side, that Langevin had worked before on a mathematical solution for describing the stochastical movement of molecules as a form of noise, see Lemons/Gythiel (1997, 1079–1081).

the three main effects of sound reflection. As I have already described, we are able to discern a dog's barking from a wolf's howling because of psycho-physical filter process that analyze periodical oscillations - aside from the dimension of experience. This Fourier analysis allows us to deal with the whole complexity of reflection processes because they alter not only the signal's run time and direction but also its quality. When a sound wave interacts with space, it is modified in a very specific way. We can navigate through space because it acts as a sound filter. Every sound is marked by a characteristic noise signature (Stroffregen/Pittenger 1995). In daily life we aren't aware of these acoustic signal processes and their huge contribution to our ability to navigate even in unknown spaces. Hence, returning to Descartes' blind man helps us understand these automatisms. Daniel Kish is maybe the most renowned proponent of what is known as human echolocation (Blesser/Salter 2008, 39–41). Jonathan Sterne and Mitchell Akiyama elaborate:

'The sounds that the echolocator produces and then receives do not represent or tabulate the world; they present it in its immediate plenitude. In the same way that the reflection of light off an object constitutes the unmediated experience of seeing, the reflection of sound off a thing constitutes an unmediated experience of hearing' (Sterne/Akiyama 2012, 553).

→
Frequency spectrum of a typical palatal click (Rojas et al. 2008, fig. 8).



But what kind of sounds are best suited to ensuring this 'unmediated', tangible form of scanning or experiencing our environment? Daniel Kish has shown that palatal clicks are ideal in two respects. Firstly, they can be reproduced very uniformly with a high intensity. Uniformity is needed for the comparison of the echo signals and the intensity at the longest possible range. Secondly, and this leads us back to the fundamental function of noise for any form of communication, the energy in clicks is spread over the entire audible frequency range:

'This rich spectral feature is very important for accurate echolocation in complex environments. The combination of a relatively simple waveform and a rich spectral content makes palatal clicks almost ideal signals for human echolocation' (Rojas et al. 2009, 11).

Daniel Kish has used palatal clicks to navigate his environment acoustically since he was a young child. This corporeal media technology has worked best for him. Today's spectral analysis can only confirm his lifelong experience. Click.

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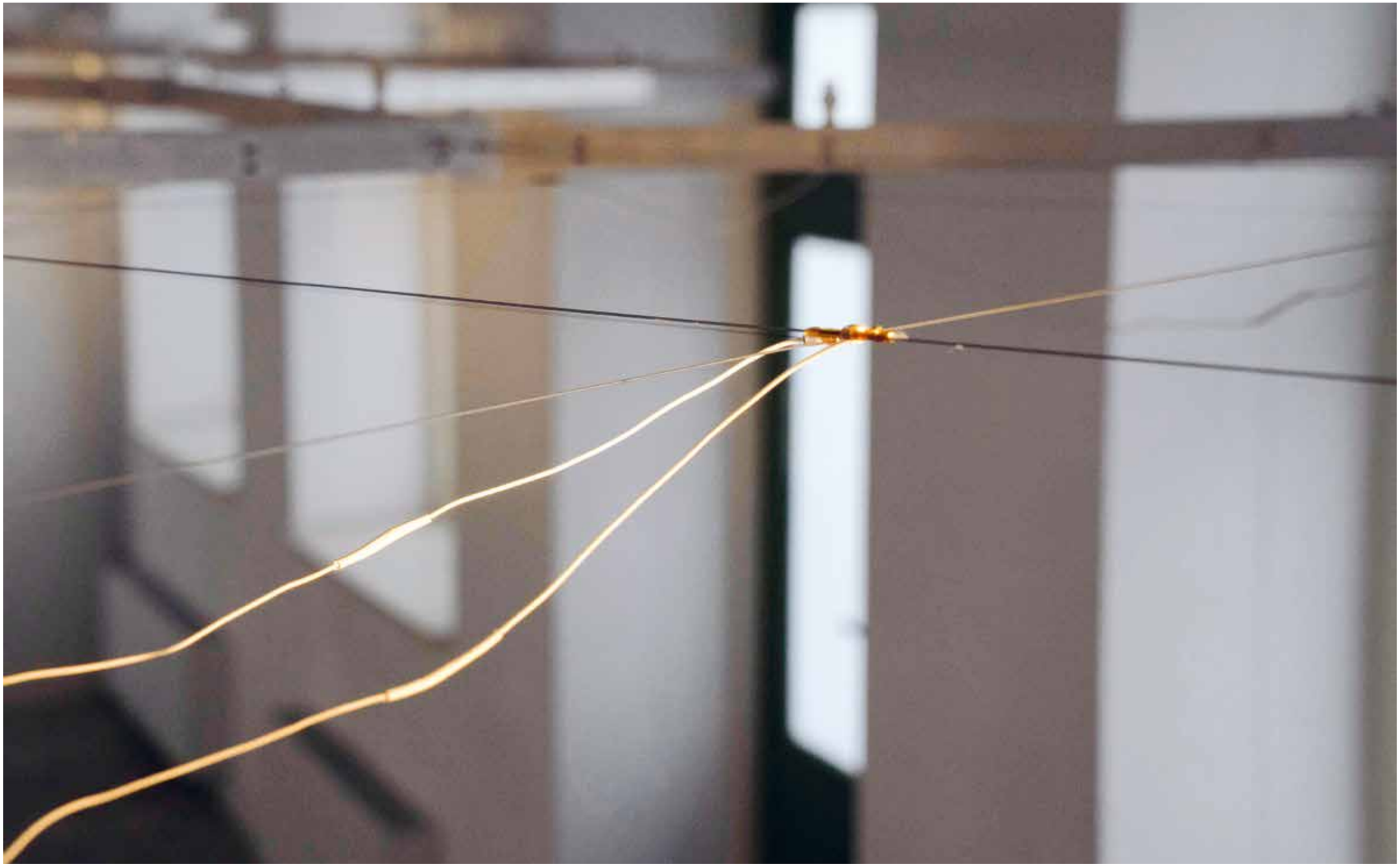
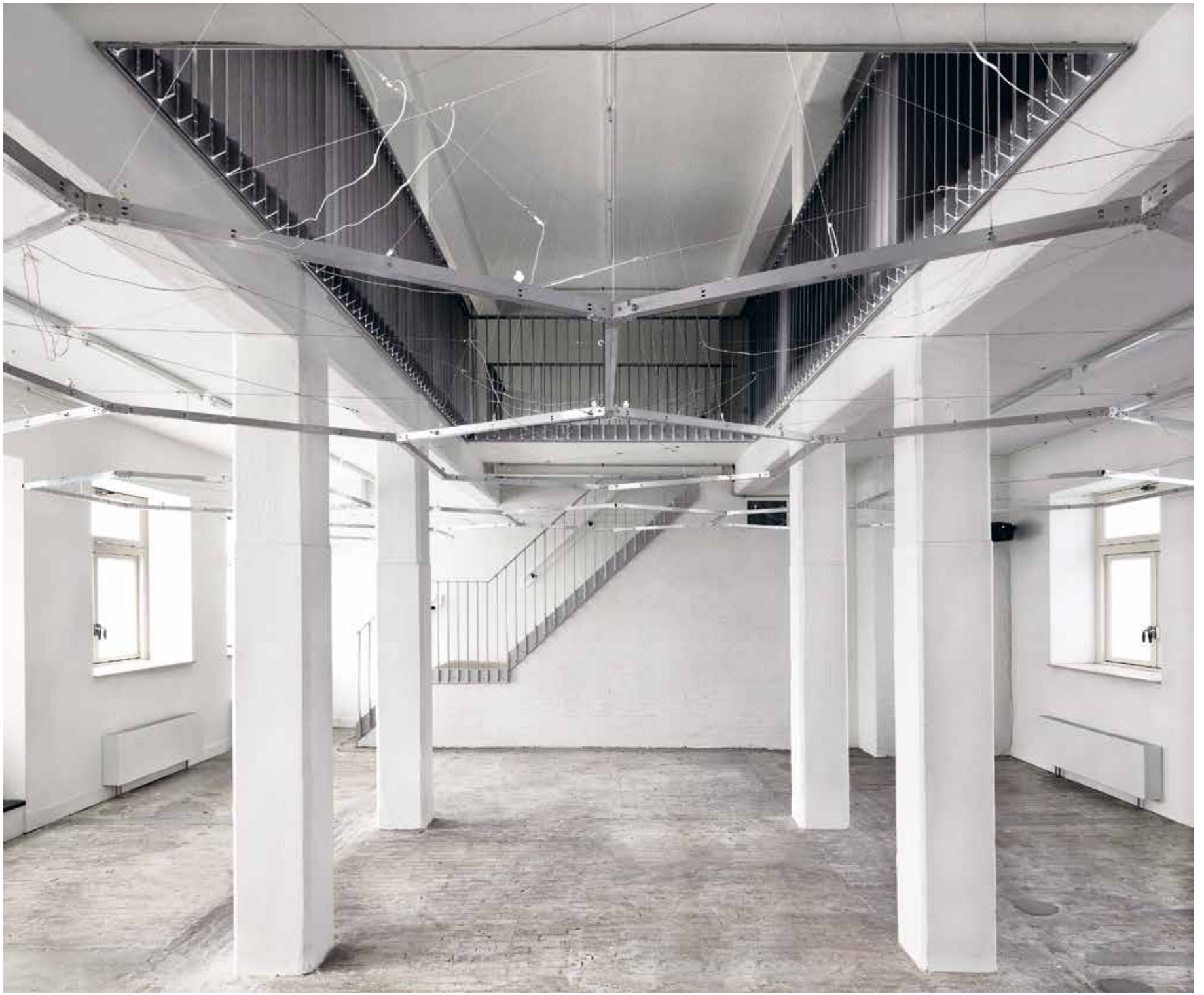
NAVIGATING NOISE



Kerstin Ergenzinger, *Navigating Noise*.



White Noise in Eight Amplified Movements

(for Clarice Lispector)

96.

African Noise Foundation

1.

I immediately perceive that I cannot be simply hearing a noise.

Hearing a noise is always in the past: No sooner do I hear the noise than I have *heard* a noise.

The very instant a noise is heard, it becomes the memory of a noise.

The only person to hear a noise is someone who has heard it *before*.

Upon hearing the noise, it is already *too late*: a noise heard is a noise *lost*.

To hear the noise is the promise of being able to hear the noise again one day.

Does thought intervene? No, there is no thought: there is only the noise.

Hearing is the essential faculty and, once used, I shall cast it aside.

I shall remain without the noise.

The noise has no *itself*. Individually, it does not exist.

It is impossible actually to hear the noise.

No one is capable of hearing the noise. Only machines can hear the noise.

Nor can anyone feel love for the noise.

My love for the noise is suprasensitive and I have no way of knowing that I feel this love.

One is unaware of loving the noise.

In ancient times I was the depository of the noise and I walked on tiptoe in order not to disturb the noise's uncanny *silence*.

When I died, they carefully removed the noise inside me: it was still alive.

Just as we ignore the world because it is obvious, so we fail to hear the noise because it, too, is so *obvious*.

Does the noise no longer exist? It exists at this moment.

Noise, you are perfect. You are *white*.

To you I dedicate this beginning.

To you I dedicate this first movement.

2.

The noise is something in suspense. It has never *settled*.

When it comes to rest, it is not the noise that has come to rest.

I take the greatest care not to understand it.

It cannot be understood and I know that if I were to understand the noise, it could only be in error.

To understand is a *proof* of error.

Never to think about the noise is one way of having heard it.

Could it be that I know about the noise?

What I do *not* know about the noise is what really matters.

What I do not know about the noise gives me the noise itself.

The Moon is inhabited by noise…

3.

The noise exposes everything.

Anyone who fathoms the noise, who can penetrate the noise's surface, is seeking something else: that person is suffering from *hunger*.

For the noise is a noise in space.

A white noise against a blue background.

Noise. I love you. I love you like something that does not even know it loves another thing.

I do not hear it. It is the aura of my ears that hears the noise.

I do not hear it. Can the noise hear me? Is it trying to fathom me?

No, the noise only hears me.

And it is immune to that painful understanding.

The noise has never struggled to be a noise.

The noise is a *gift*. It is inaudible to the naked ear.

A noise needs careful handling.

This is what a mother is for.

The noise lives like a fugitive because it is always ahead of its time: it is more than contemporary: it belongs to the future.

It lives inside the body so that no one may call it white.
The noise is really white but must not be called white.

Not because this would harm the noise, which is immune from danger, but those people who state the obvious by describing the noise as white renege on life.

4.

A noise is the most naked thing in existence.

Regarding the noise, there is always the danger that we may discover what could be termed beauty, in other words, its utter veracity.

The noise's veracity has no semblance of truth.

Our advantage is that the noise is inaudible to the vast majority of people.

And so the noise puts us at risk.

She does not know that the noise truly exists.

Were she to know she has a noise inside her, would she be saved?

She only exists on behalf of the noise.

She suffers from some strange malaise.
Her strange malaise is the noise.

The slightest threat of danger and she screeches her head off.

All this simply to ensure that the noise does not break inside her.

The noise which breaks inside her has the appearance of blood.

She watches

5.

the horizon.

As if she were listening to a noise slowly emerge from the distant horizon.

How can she understand herself when she is everything the noise is not?

She neither recognizes the noise when it is still inside her nor when it has been exteriorized.

When she hears the noise, she thinks she is confronting the impossible.

And suddenly I hear the noise in the kitchen and all I see there is food.

My heart is beating fast. Something is changing inside me. I can no longer hear the noise clearly.

Apart from each individual noise, apart from the noise one consumes, the noise no longer exists for me.

I can no longer bring myself to believe in a noise.
I find it more and more difficult to believe, I am weak and dying.

Farewell.

I have been listening to a noise for so long that it has hypnotized me and sent me to sleep.
I am still talking about the noise.

Only to realize that I do not understand the noise.

All I understand is a broken noise: broken in the

vacuum cleaner.

And this is how I indirectly pledge myself to the noise's existence.

6.

And from this very moment the noise no longer exists.

I belong to the freemasonry of those who, once having heard the noise, reject it as a form of protection.

Anxious to avoid destruction, we destroy ourselves.

Love is not a prize. It is a state conceded only to those who would otherwise contaminate the noise with their private sorrow.

This is the sacrifice we make so that the noise may be formed.

7.

The noise sizzles in the frying pan and, lost in a dream, I prepare breakfast.

Without any sense of reality, I call the children who jump out of bed, draw up their chairs and start eating and the work of the day which has just dawned begins, with shouting and laughter and food, the white noise provokes laughter.
It makes me smile in my mystery.

They have also allowed me time so that the noise may form inside me at its leisure but I have frittered away my time in illicit pleasures and sorrows, completely forgetting about the noise.

Or is this precisely what they wanted to happen so that the noise may be formed?

For with my wandering thoughts and solemn foolishness I might impede what is happening inside me.

My heart beating with emotion, yet without understanding anything!

My heart beating confidently, yet leaving me baffled.

8.

But what about the noise?

As I was talking about the noise, I forgot about the noise.

'Keep on talking, keep on talking,' they told me.

And the noise remains completely protected by all those words.

Out of devotion to the noise I forgot about it.

Forgetfulness born out of necessity.
For the noise is an evasion.

Confronted by my possessive veneration, the noise could withdraw never to return and I should die of sorrow.

But suppose the noise were to be forgotten and I were to make the sacrifice of getting on with my life and forgetting about it.

Suppose the noise proved to be impossible.

Then perhaps – free, delicate, without any message whatsoever for me – the noise would move through space once more and come up to the window I have always left open.

And perhaps with the first light of day the noise might descend into our apartment and move serenely into the kitchen.

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Wandering

Off.

In Conversation with
Kerstin Ergenzinger and
Patricia Pisters

Nathanja van Dijk

You are guaranteed to end up in a rich conversation when you bring together an artist and an academic who both defy disciplinary boundaries, fuelled by their belief in the need for noise. So when I sat down one day with artist Kerstin Ergenzinger and academic Patricia Pisters to talk about Kerstin's art installation *Navigating Noise*, we embarked on an exploratory journey through the soundscapes of the installation, leading through the realms of art, science, philosophy, and back again. This text is based on our day-long conversation, in which we discussed the need to hear noise beyond the layers of order and unity that we have imposed upon our world, about bodies without organs as well as bodies in the world, about the act of walking, and about navigating noise as a fundamental component of our engagement with reality.

Noise is the backdrop of the universe

'Noise is not a signal yet', says Patricia over a first cup of coffee. The conversation takes off where most discourses end, defining noise as a fundamentally relational phenomenon, being the foreign element of language, structure, and meaning. Within this relational framework that supports the notion of noise as the opposite of signal, noise is an inherently elusive force. It will disappear the moment you try to put your finger on it, absorbed into a system of meaning and thus remaining out of reach (Hainge 2013, 273). Following this logic – which is native to information theory and corresponds to our everyday understanding of noise – noise can be regarded as an abject and external force (Goddard et al. 2012, 45).

Informed by the idea that noise is the *unwanted* antithesis of signal and system, 'we have been trying to clean up our world ever since the Enlightenment – the dream of pure reason – aiming to eliminate or at least reduce noise', says Patricia. 'We have become afraid of uncertainty and unpredictability, especially when (scientific) knowledge is popularized.' However, she immediately adds that when we look at our world today, it is extremely chaotic and much more noisy than the clear and distinct systems that we have created to make

sense of our surroundings. In our rapidly changing, highly mediated, and globalised society, noise – and thus uncertainty – seems to permeate all aspects of our lives. Kerstin agrees that noise cannot be silenced by an overarching system of meaning. What's more, according to both the artist and the academic, we should treat noise as a fundamental component of all knowledge and communication systems. Noise is the indelible and pervasive component of our engagement with the world.

Reflecting on our conversation, it makes sense to refer here to Michel Serres's publication *Genesis* (2005), a mind-boggling exploration of the chaos and multiplicity that underlie the layer of order and unity that we have imposed upon the world. The French philosopher describes noise as the ground of our perception. Absolutely uninterrupted, it is the perennial substance.

In his theory, Serres makes a distinction between 'parasitic perturbation' (noise as a disruptive and transformative relational force) and 'background noise' (noise that prefigures phenomena). It is the latter that is foundational and, at this point, of most importance to the conversation with Kerstin and Patricia. Serres writes:

'Noise cannot be a phenomenon; every phenomenon is separated from it, a silhouette on a background, like a beacon against the fog, as every message, every cry, every call, every signal must be separated from the hubbub that occupies silence in order to be perceived, to be know, to be exchanged. As soon as the phenomenon appears it leaves the noise, as soon as a form looms up or pokes through, it reveals itself as veiling noise. So, noise is not a matter of phenomenology, so it is a matter of being itself. It settles in subjects as well as in objects, in hearing as well as in space, in the observers as well as in the observed, it moves through the means of the tools of observation, whether material or logical, hardware or software, constructed channels or languages; it is part of the in-itself, part of the for-itself, it cuts across the oldest and surest philosophical divisions, yes noise is metaphysical' (Serres 2005, 13).

Serres's 'background noise' is not loud. We are often unaware of it. However, it is omnipresent and inevitable rather than secondary and contingent. It surrounds and forms us, is beneath and beyond us, as the omnipresent, incalculable, and unpredictable raw material from which a signal comes *and* where it goes. Noise remains out of reach – not because it is absorbed in a system of meaning, but because 'background noise is permanent, it is the ground of the world, the backdrop of the universe' (ibid, 62).

We should not 'turn a deaf ear' to noise. Instead, Serres argues, we should try to hear – through both its content and form – the noise, the sound and the fury, that are the conditions of life and thought. In line with Serres's thinking, both Kerstin and Patricia believe that navigating noise is essential for our understanding of the chaos and multiplicity, of the eventful and noisy reality that we are part of. Patricia says: 'Accepting noise as the constitutive component of all knowledge systems is an attempt to break free from today's fear of uncertainty and an attempt to reconnect to the subliminal, unheard forces in the world. Kerstin's work deals exactly with these subliminal forces on both a material and metaphysical level.' So it is perhaps through art that we can start hearing the chaos and multiplicity that lie beneath the layer of order and unity that we have imposed upon our world.

Quiet noise

Although the name might suggest otherwise, Kerstin's installation *Navigating Noise* is not loud. On the contrary, it is a rather quiet piece that could come across as 'shy'. Upon entry, the exhibition space might seem to be empty, before one can start to perceive the sounds that emanate from the ephemeral art installation. *Navigating Noise's* soundscapes are fragile and can easily be disturbed (or destroyed) by loud interruptions invading the exhibition space, or even by the noise in one's own head. In this respect, the installation brings to mind Serres's 'background noise'. The senses, the body, the mind need to acclimatize to the work, like the eyes need to adapt to the dark. Kerstin elaborates on the importance of this form of

scaling down or reduction within her work: 'Due to its relative quietness, the piece asks for a heightened form of awareness, which will sharpen your perception and allow you to sense the quiet noise of the installation.'

The soundscapes of *Navigating Noise* emerge from a honeycomb-shaped aluminium structure that is suspended in space. Through the hexagon structures, Kerstin has woven over a hundred metres of piano wire that are connected with Nitinol wire. This ultra-thin robotic muscle wire is set into motion by the voltage pulse of digitally modulated frequencies coming from the controlling programme. As a result, the installation is brought to life by the vibrating piano wire and the resonating aluminium body, creating an endless range of sound qualities. The input frequencies simulate natural and man-made phenomena – such as the sound of crickets or the noise of a far-away construction site. Kerstin based the digital input on the spectrum of frequencies and amplitude of the simulated phenomena.

Navigating Noise is a hybrid of a metal and a string instrument, of a machine and a creature. Its sonic output is unpredictable, chaotic. The input frequencies are filtered and transformed by the installation's body of metal and strings, as well as by the mechanics responding to friction and temperature. *Navigating Noise* is a subtle perceptual machine that detects and responds to your movements in space. While you move through the space, the soundscapes constantly shift their tone of voice, translating the observer's whereabouts into changing acoustic fields by means of a complex feedback system. You will always remain uncertain about the relationship between cause and effect – between stimulus and response. *Navigating Noise* is programmed so that it seems to follow its own logic, as if it could decide independently whether to respond directly to your presence or to withdraw and ease back into an intentionally elusive state of being. Hence, within Kerstin's world of sounds, navigating noise is an inherently noisy endeavour. The work calls for a constant re-orientation by the observer in relation to space and sounds, while the act of sensing and sense-making merge.

Navigating Noise constitutes a highly abstract environment. But eventually the observer will discern structures and patterns within the abstract noise, while trying to make sense of the complex flow of sounds. For instance, some people 'heard' the ominous swell of drones, little flies, or creaking doors. Patricia recalls that *Navigating Noise* invokes associations, which in her experience are not visual nor do they relate to specific situations. While wandering through the soundscapes, she distinguished rather abstract moods reminiscent of the 'sound of metal', sounds that Patricia links to Gilles Deleuze's and Félix Guattari's conceptualization of metallurgy. In their book *A Thousand Plateaus*, the French philosophers and psychotherapists write: 'Metallurgy is the consciousness or thought of matter-flow, and metal as the correlate of this consciousness … Metal is neither a thing nor an organism, but a body without organs' (Deleuze/Guattari 2005, 411).

Both a 'thing' and an 'organism' indicate an extensive and discrete account of matter. The body without organs, on the other hand, is a way of thinking about matter that is not yet formed, matter that flows. Deleuze and Guattari have cleared the way for a non-represented body. The body without organs constitutes the 'virtual' dimension of the actual body: a reservoir of potentialities, connections, affects, and movement. These potentials are mostly activated (or 'actualized') in conjunction with other bodies (or other bodies without organs).

Patricia relates Deleuze's and Guattari's concept to *Navigating Noise*. The body without organs is a language pushed to its non-signifying limit, or, in Patricia's words, *Navigating Noise* is a "word" in 'the making'. Kerstin's installation constitutes an uncertain system, which is permeated by (sonic) flows in all directions, whose potentialities are activated when coinciding with other bodies: in conjunction with us. *Navigating Noise* is in a state of 'becoming', continuously creating itself anew, allowing us to re-experience our own perception and renegotiate our (unstable) position within an unpredictable, chaotic world.

Over lunch we continue talking about Deleuze. Patricia is getting fully into her stride, since her academic practice is deeply embedded in the philosopher's thinking. In recent research she has investigated his theory in conjunction with neuroscience. Besides the delicious home-cooked lunch, Patricia brings to the table Deleuze's notion of art as a form of thought (a cerebral experimentation), outlined in the book *What is Philosophy?* (1994) that Deleuze wrote in collaboration with Guattari. They differentiate between art, science, and philosophy as means of dealing with reality: as forms of navigation through the chaos and multiplicity that is reality. We could see art, science, and philosophy as manifesting certain capacities of the brain in confrontation with chaos. Where philosophy cuts through chaos with concepts and science produces experiments and functions, art works through *and* as material, constituting a compound of sensations, percepts, and affects. Patricia argues that it is in the realm of art where thought and experience meet. '*Navigating Noise* is a form of thought, yet at the same time it is not abstract at all. *Navigating Noise* is also an embodied experience', she explains.

Kerstin's sonic architecture constitutes a metaphorical space, linking a physical, sensory experience with an abstract notion of noise (of chaos and multiplicity, as 'the backdrop of our universe'), drawing a parallel with the way we approach the world and the continuous orientation and searching control. With her work, Kerstin renegotiates questions about the relationship between body, perception, and reality. How do we make sense of what appears to be noise? How do our bodies relate to other bodies? How do we orientate ourselves within diffuse surroundings, and how do we understand our position within an unstable, chaotic world?

Central themes within Kerstin's artistic investigations are the inextricable relation between the body and the world, between perception and the perceived, between sensing and sense-making. Seeing, listening, touching, and smelling are

not only physiological facts, but can also be considered acts of engaging with the world. Because it is in the engagement with the world that the world – and oneself within that world – is constituted. In relation to Kerstin's sound installation *Navigating Noise*, it is relevant to refer to Jean-Luc Nancy's essay *Listening* (2007), in which the philosopher examines sound in relation to the body, differentiating between the French verbs *etendre* and *écouter*. Nancy emphasizes *écouter*, which holds open the threshold between sense and signification. Here, listening means both hearing and understanding, sensing and sense-making.

Nancy's ideas about listening are related to Maurice Merleau-Ponty's conception of the body. According to the French philosopher, meaning comes into being as our bodies enter into a relationship with the world. Our sense-making of the world always takes place within the world of our lived bodies. Our senses are the 'dimensions' by which we come to realize and interrogate ourselves as beings in the world. Not only does perception unfold us within the world we perceive, it is primarily a fundamental condition of our existence, an existence that is perceptually sensed and 'made sense of'. Sensing discovers and generates the sensed. In other words, I draw my sense of the world, to which I give a sense by perceiving it. So the sensible is directly connected to the intelligible (Merleau-Ponty 2002, 235–279). Following Merleau-Ponty, we can say that by inhabiting an environment, we create a meaning of environment. Furthermore, to move in the space is also to move within the self. The thought is as the movement, which changes with the situation, while the situation changes with the movement.

Wandering off

Kerstin's artistic practice is deeply interwoven with movement, with the act of walking. Although her work is often ephemeral and highly technological, it is intimately connected to her physical experiences, perceptions, and investigations during the long hikes she takes with her partner Thomas Laepple, in unknown, often remote territory.

When moving through the landscape, she closely observes the consistencies and subtle changes of the surroundings: the horizon subtly shifts, vistas open up only to disappear again behind rock formations, changing weather conditions and elusive cloud formations. With the help of photography and drawings, Kerstin aims to meticulously record the changing perspectives. While her gaze wanders back and forth between the far distance and her sketchbook, she often 'loses her way'. Despite the precise indications of location and time, the drawings bear witness to the lack of orientation you can experience when trying to understand your position within the vast landscape.

The experience of the hikes brings back childhood memories. Kerstin grew up in the south of Germany. She tells us about the mountain in her backyard, which was 'her world'. As a child, she spent endless hours exploring its territory, throughout every season. She would collect objects, observe the insects and other animals, and would explore the terrain, often on her bare feet, over and over again. Kerstin explains that many of her experiences from her 'mountain world' lie at the heart of her artistic practice. For example, her memory of the quiet noise of the high voltage cables hovering above the natural terrain of the mountain laid the foundations for her installation *Navigating Noise*. However, her strongest childhood memory is of the heightened sense of awareness she would experience, navigating her surroundings while getting lost in thought, creating her own reality. Kerstin says: 'It is an experience of being able to deeply connect to the world: an experience that I can reconnect with during the long hikes and that resonates deeply into my artistic practice.'

When embarking on a journey into unknown territory, your first steps are tentative, unstable, adjusting to the uneven surface while looking for navigational points on a distant horizon. After a while the body will find its so-called *Trittsicherheit* (sure-footedness). Kerstin describes this experience as the body entering its 'machine-mode'. She recalls how you are constantly reminded of the needs of that machine through thirst, tiredness, sometimes pain. On the other

hand, while crossing the landscape in a rhythmic flow, the mind is set into motion and wanders off on its own. Kerstin describes this mode as a heightened form of awareness, of being both 'outside' and 'inside' at the same time. To move in the surroundings is also to move within the self. Walking is as much a physical experience as a pensive observation. Sense is created 'on the go' and acted out in an embodied way. The experience of being thrown back in reliance on our bodies reminds us of the fact that making sense of the world is a noisy, fleeting, never-completed process. It is a continuous act of navigating noise.

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An Ecology of Noise.

Three Orientations

Brandon LaBelle

124.

The installation work by Kerstin Ergenzinger, *Navigating Noise*, eases into an existing space, spreading in and around found structures, tensing architectural borders with another type of logic. It nestles amongst the life of a place, animating particular movements through added layers of sonic matter, as small events that contribute to a growing, organic operation. I start to hear the work, and its complex unfolding, as an ecology of noise, one that I'd like to detail by way of three orientations. These are offered as speculative pathways into the work's *eventness*, as well as extending away, to reach for associations and spectralities, for every ecology is a complex configuration of overlapping and intersecting entities and life-forces that interweave an array of presences, some more tangible and concrete than others. In this sense, I approach the installation as an extended body of related singularities to highlight its aesthetic of multiplicity, this interweaving, as well as my place within it: as an organic body myself, navigating noise while also contributing to it – my breath, my footsteps, as well as my *dreaming sensibility* that follows the work's aesthetic project as a platform for journeying and participating.

Stars

Like a constellation of secret stars, the installation draws my attention upward, to what is above – to marvel at the bristling of these bright sounds. I'm placed upon a vertical axis, relating what is above to what is below, to the events of an auditory plane that invites one to look up – to listen upward. There is a shimmering quality to the sounds, these sounds that hover within a small universe. In looking up, I'm also brought down; I'm drawn to the floor. Lying down, I'm reminded of summer nights when my brother and I would lie in the grass to look at the stars, with the sound of crickets in the nearby bushes, adding their singing to the mesmerizing array of small lights above. Within Kerstin's installation I'm drawn back to this memory, associating the interplay between the senses – the concrete feeling of the body on the ground, the plane of earthly presence, in contact with the dimension above, this listening upward which invites us into an aerial thinking: to meditate upon the universe as my brother and I would do. Why do the stars inspire us to reflect upon the conditions of life? To pause, and to seek the hidden meanings that seem to exist above, out there? Staring up at the honeycomb-shaped frames suspended in the gallery, it's as if I'm asked to listen beyond: beyond the hard matter, the metallic elements, and the concrete surfaces, and toward the deep void above, the one that is always lurking. I would say that the void of the sky, with its aerial characters and nebulous events, orients us toward a height that is deeply physical as well as purely imaginative. It is by way of the lofty dimension, as Gaston Bachelard (1992) suggests, that we orient ourselves as *dreaming beings*. Climbing upward, toward eternal heights and the aerial expanse, thoughts lighten; filled with the air of imagination and the trembling softness of poetic capture, they take flight. While the ground, and further down, the underworld – the cavern or the cave, the cellar or the subterranean – bring us deep into the body, toward the ground of pragmatic thought and daily chores, as well as the corporeal appetites, the aerial, in contrast – by way of the upper storey, the attic, the cloudy dimensions – invites us to speculate, to dream of other worlds and other selves. The stars give animation to such dreaming; they are the final points, the deepest reach such thoughts may travel, and as such, they orient us toward the beyond, and the celestial life, through their shimmering. They illuminate journeys, being not only poetical triggers by which thoughts may travel, but the guiding configurations that enable navigation. Stars, in this regard, are deep partners to the human condition, enabling a spirit of drift and distraction as well as the possibilities of finding new worlds. Yet stars, as must be remembered, are full of noise; as bursts of primary matter, they carry the thrust of an expanding universe – stars may be seen and heard as planetary objects thrown from a shattered structure and vibrating with energy. The airy dimension and the celestial plane are thus reverberant with a type of violence, a rending intensity. In listening upward, we are oriented as well as elevated by the primary thrust of origins.

Labyrinth

I try to find a beginning and an end; for some reason, I grow curious about edges. I walk toward the gallery walls, I search for points of entry and exit: where does the installation begin? Instead, I am always circling back in, each step folding upon itself, retracing its path. Rather than a loop, I discover an array of interconnections – the installation is constituted by relations, with things rushing forward, to form a type of micro-structure, and others receding, scaled back, to articulate on a macro-level another dimension, another stratum. Everything becomes a question of detail, with one nested inside the other. With the structure full of vibration, something starts to tremble: lines become nerves, strings become threads, the structure becomes a transmitter. If I start to enter into the installation's trembling composition, this array of interconnections, it's as if a mysterious labyrinthine form appears; a maze into which my listening enters, one that is inspired to interconnect and, in doing so, the often dominating linearity of one's direction diffuses: *where is the beginning and the end, I wonder?* Within this particular ecology of noise, one is always close to that formless 'bubbling' Michel Serres (1997) describes as the fundament of language: a mass of matter, a static, a noise that underpins and makes possible the formation of meaning. From within the matter of noise, words start to appear; they take shape from within the formless ooze of babble – we find our way, as we must, through the labyrinth of worldly existence. In short, we become immersed in relationships. Yet, language is always connected to its origins within babble, and the noisy rush of things, as the energetic fundament of materiality perennially glides around our social formations to interrupt at times, and to interfere. Finding my way in and around Kerstin's installation, I seem to hover on the edge of language, close to the rush of noise this orientation is based upon. Instead of the beginning and end of articulated speech, I'm placed within a maze of interconnections, rushing forward and receding back, amidst fragments, like an oceanic flux into which my listening is tossed: suddenly, I surrender to the trembling vibrations, this babble that gently interferes. In doing so, I start to detect

the order within the chaos, and the chaotic foundation every order contains. That is the beauty of this particular ecology of noise, one that orients by remaining close to the power and poetics of disorientation.

Reflections

In relating to the particular form and events of Kerstin's installation, I'm also relating to myself as a figure within the gallery space; as a work based on real-time processes, I am given back to myself the features that constitute the time and space of the work, and the moment of its becoming, which always includes myself. Small whirring sounds that shift and erupt as blossoms of metallic tones, and that I intuit as being connected to my presence; the movements of vibrations that tremble its structures and that move along with my own; and the acoustic reflections that echo around, forming another movement of time and space, *like a ghostly other*, bringing to life the life that is. As a participant, I am implicated in the slow unfurling of this ecology of events, this realm of sensitivity and sensing, as a body brought into attunement with all that surrounds it and that is always closer than imagined, to form a greater composition. In this instant, I begin to hear not only the installation, but additionally my own hearing, the hearing of and in myself. It draws myself out of hiding, animating myself through a second body, this metallic structure and its resonant armatures. In doing so, it shows myself to myself, yet as an external figure, a reflection amidst other reflections, pronouncing in its subtle way the entanglement that always is, and that is defining for any ecological view: the entanglement of life forms, the compositions that unfold as fragile constructs, that mesh and that require of us a state of deep sensitivity. I move, I listen; I relate and am brought into relations. I am tuned and I am interrupted, at the same instant, by these events that I sense, and that sense myself, and which participate in a greater constellation of sensations, what Jane Bennett (2010) suggests by way of what she terms 'vibrant matter'. Considering the interconnectedness and 'vital materialism' at play across matter and things, subjects and objects, Bennett leads us toward the emergent force that

arises as bodies join together. A becoming set in motion from the assemblage of parts, and which gives way to an energetic construct of relations. Accordingly, I'm tempted to suggest that under the force and power of such vibrant models, art may form the basis for drawing out a deeper relation to the extensiveness and interdependencies of which we are a part; for assisting in navigating through the glowing and gripping entanglement at work in and around and through us. Art, which fundamentally relates itself to the question of materiality and the possibility of other worlds, is a type of compass, leading us into the arenas of power and force, territorialities of meaning and representation, of sensate bodies and their desires, and the discourses drawn from conflicts of culture and social structures. In doing so, art may orient us within the complicatedness of all this movement, and as vibrant matter it may inspire the project of consciousness, inciting a depth of reflection that turns us toward essential questions.

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Stars, *labyrinths*, *reflections* … these become focal points as well as vanishing lines that emerge as I encounter Kerstin Ergenzinger's installation. Attending to the work's materiality and eventful dynamics, I'm led to experiences of seeing and listening that are no less ecological than they are sensorial, singular as well as immediately plural. *Navigating Noise* is both factual and speculative, insisting upon its metallic construct and wiring as well as its shimmering vitalism, its *otherness* – these sounds that I listen to and alongside. Moving in and around the installation, the work acts as a floating coalition – a structure that gives residence to matters and memories, actualities and associations. Noise, in this regard, seems to be a force that agitates the architectures and environments that surround us while prompting us to find creative routes through sonic interruptions. To take the encounters with strange sonorities as opportunities for deepening the listening sense.

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Sono-Aesthetics

Eleni Ikoniadou

134.

Introduction

I am standing in an empty room occupied by Kerstin Ergenzinger's installation *Navigating Noise*. It is almost silent here. Implicit and incipient energies suggest the existence of a forcefield that I am unable to discern, but whose action gives the space its torsion and rhythmicity. As the pulsating darkness engulfs my body, there is nothing left to be, nothing to perceive or recognise, yet anything is possible from one moment to the next. Sight and even hearing gradually retreat into the background, revealing to cognition its own irrelevance and redundancy. The I which I am not is redefined as a contingent entity, tied to any other, touching and interpenetrating in ways not necessarily accessible to thought or senses. This is a purposeless structure, a room for not seeing, not doing, and not knowing. If it has any affinities with sound, art, technology, they are purely a point of autoignition. The sonic artwork turned rhythmic event: a 'potential bearer of new constellations' (Guattari 1995, 18) waiting to be activated by the tremor. The aluminium beehive-shaped structure suspended above my head is made with piano wire interconnected with robotic muscle wire, and as I walk around underneath it, it vibrates; at times with real intensity and others very subtly. As I navigate its noises and different sonic states, my perception of the space, of my body, of other bodies around me shifts, leading me to think about the capacity of aesthetic experience to generate change and, crucially, about the problem with undermining it. The power of a (sonic) artwork to probe larger theoretical questions about aesthetics is nothing new, but, in the face of recent attempts to exclude the value of aesthetics from thought, it is perhaps a topic worth revisiting.

In order to rethink aesthetics and what it can do today, it is perhaps necessary to summon approaches of questioning that cut across disciplines and go beyond the intentions embedded in them. Rather than a mere archaeology or classification of ideas, the transdisciplinary investigation should be entered into with the intention to invoke, map, channel, ignore, or emphasise the strange and unexpected findings of our excavations. To this end, any attempt to rethink aesthetics is also an act of catching different kinds of thought and practice at a creative crossing. On one level, we think through expression, and this is why writing is an act of confrontation with the unknown. By naming her characters, places, and events, the writer causes them to exist in other people's minds, laying bare the slippage between invention and discovery. On another level, an artwork such as *Navigating Noise* can become a gateway from which all thoughts, ideas, and discussions emanate. As the Acts of Orientation symposium demonstrated, an artwork can be at the centre rather than at the periphery of academic debate, shaping and directing rather than merely accompanying it.[1] The question then posed to the artist by a participant in the installation – 'will your project revolutionise the world?' – gets a positive response; as we learn from it to follow the artwork's own expressions and affects in order to make sense of the world, rather than bestow theoretical interpretation upon it in order to give it significance and meaning. Artistic practice calls forth unsettlement and borderline uncertainty. However, so does scientific inquiry into what remains stubbornly and radically unknown. Thinking through writing, making art, sound or scientific inquiry, could be understood as what Brian Massumi and Erin Manning identify as 'facets coming formatively, reverberatively together, if only to form the movement by which they come again to differ' (2009).

1 'Kerstin Ergenzinger: Acts of Orientation' was an exhibition that took place in Berlin at the Ernst Schering Stiftung between 29 May and 27 June 2015. The show was accompanied by a symposium that discussed ideas emanating and relating to the showcased artwork, *Navigating Noise*.

The background

In the age of absolute computation, where there is no off switch and nothing exists outside the technological zone, it is clear, now more than ever, that our idea of what it is to be human is fundamentally changing. The very notion of life as exclusively natural or biological has been challenged by advances in genetic engineering and artificial life, as well as experiments in bioart, media art, and other practices. Despite notable efforts to define our era as the anthropocene and to ensure the future of humanity beyond the destruction of this planet, as spawned by anthropos, there is a sense in which life, reality, spatiotemporality, and experience might not be

strictly human-centred or human-oriented. Eugene Thacker, for example, asks, 'What if life is not reducible to biology – but also not reducible to "consciousness", "spirit", or "intellect"? What if life is never self-evident in lived experience?' (2010, x). Equally interesting is Dylan Trigg's approach; he writes, '… the emergence of life in the subject does not entail the human body as a unique vehicle of understanding. Instead, the body presents itself as a variant of a formless and indestructible force, a brute animality whose only characteristic is a propensity to disguise itself in other bodies … horror involves the intersection of the human and the nonhuman' (2014, 38). And Thomas Metzinger, in his Ego Tunnel theory, writes 'there are innumerable things in life you can fathom only by experiencing them, [but] there is a depth in pure perception that cannot be grasped or invaded by thought or language' (2009, 50).

There is currently a growing effort to find ways of reorientation within the new reality. Digital humanities, software studies, body studies, and environmental humanities are some of the fields from which innovative methodologies and ground-breaking experiments are presently emerging. Certainly, neoliberal digital capitalism, drone warfare, drastic ecological change, and technoscientific discourse that casually dismisses other fields of knowledge as irrelevant are part and parcel of this new complex reality. This is undoubtedly a time when the arts and humanities are under attack, seen as 'luxury disciplines' not worth investing in by right-wing governments across the Western world. There is a casual spreading of physicalism in the social sciences, the reductionist and eliminativist approach that divides the world between the ones who know – through a reliance on science – and those who just believe. Certainly in the UK and Germany, but also globally, it is evident that STEM sciences are fast becoming the new temple that marks the separation between the rational, knowledgeable definition of our world and everything else that may be dismissed as a matter of opinion. This silencing of other ways of thinking about the world is marked not only by the neoliberal agenda, but also, astonishingly, by philosophers keen to exclude other forms of 'minor science' and alternative

approaches to the question of knowledge. And yet, science, too, needs its beliefs. Maria Hellstrom-Reimer (2015) discusses the importance of knowledge, taking into account partialities: MythScience, for her in relation to Fahlstrom's artwork, but, interestingly, this is also a field of knowledge invented by the sound experimenter Sun Ra: fiction making reality, proliferating improbability.

Although it is important to avoid proposing that 'anything goes' (for example, that knowing and feeling are the same, or that any field of enquiry is the same as any other), it is also fundamental to cast aside the more archaic, somewhat vulgar practice of endowing one field of thought with a legitimacy and holiness that is not enjoyed by others. As Stengers reminds us, our position should not be that of the judge deciding 'what to admit and what to leave out of the theory hall of fame' (2011, 373). What is more interesting, she stresses, is 'practice, the plurality and diverging character of practices' (ibid), what Donna Haraway calls 'agility sport' - the potential for cross-species mutuality. It is worth quoting a longer passage by Stengers here: 'What is needed instead, and drastically so, is that experimental achievement not be abstracted from the practice that produced it; that experimental objectivity be not transformed into the normal reward for a general rational or scientific method… What is needed against scientists' exceptionalism is that the experimental achievement be indeed celebrated as an event, as the exception, not the rule' (2011, 376). Stengers, like Latour, prompts us to renounce the mobilisation of science as the realm of absolute supremacy, one that can only provide its claims to the truth by destroying all other points of view. And this is not exclusive to science. Philosophy has equally been endowed with a halo whose legitimacy we must question. Yet the point here is not to abandon science and philosophy altogether, but rather to understand them in the specificity of their practice, thereby rejecting their associated pretensions to universality. Practises of experimentation, such as those of the sonic, provide grounds for challenging the concreteness of disciplinarity and the leaking into each other of ideas and processes. Contrary to being perceived as some new trend, this cross-pollination

has always affected the different disciplines but is today something that can no longer be ignored, an accelerated force of contamination.

For this article, what is intriguing about developments of late – across cognitive science, speculative theory, and sonic experimentation, for instance – is how they might impinge upon and relate to one another, as well as within their own heterogeneous dimensions. Having had, first, to come to terms with the unknowability of the world, as well as its existence without us and its complete indifference to us (as shown by Thacker, Metzinger, and others mentioned previously), it might be fruitful to find other ways of orientation that presuppose the coexistence of ideas; that is to say, to move away from the mere tolerance of other worldviews towards actively enabling the negotiation and co-intervention of different methods and discourses. My argument is that sonic experimentation, theoretical and practical, has the potential to reorient and unsettle previously stable and stagnant concepts and ideas, such as aesthetics, when it plugs into other areas of thought and practice.

For an adequate theory of art and sound

Although we are still far from the degree of transdisciplinarity required to redefine a concept such as aesthetics, minor steps have been taken by thinkers such as Gilles Deleuze and Félix Guattari, whose work strived to bring out the reciprocal contagion of techniques and disciplines. For Guattari, transdisciplinarity is 'a call to rethink relations between science, society, politics, ethics and aesthetics' (Genosko 2002, 24). As he states, 'Now more than ever, nature cannot be separated from culture; in order to comprehend their ecosystems, the mechanosphere and the social and individual Universes [capitals in the original] of reference, we must learn to think "transversally"' (Guattari 2008, 29). As we learn from Deleuze and Guattari, to enable and conceive new subjectivities, social relations, and environments, we need all three 'daughters of chaos' – art, science, and philosophy – as forms of thought or creation that act together to cut through the chaos. Moreover, one of the most insistent refrains in Deleuze and Guattari's work, both together and individually, is that we must look for alternative paradigms to the ones inherited by post-Enlightenment modernity and, in fact, return to aesthetic ones. For them, aesthetic utterances can anticipate scientific advances by decades. To this end, as the Acts of Orientation symposium showed by placing an artwork at the heart of the event (and out of which all ideas and discussions emanate, as I mentioned earlier), it seems important to refuse the marginalisation of aesthetics and to allot it a central position in our uber-technological age. As Professor Wolfgang Ernst insists, everything is already there in technology: science, philosophy, and aesthetics.[2]

2 Private conversation with Ernst during the launch of *Navigating Noise*, May 2015, Berlin.

A complete dismissal of a theory of aesthetics presents a problem for us. For example, for the otherwise fascinating nihilist thinker Ray Brassier, new developments in the natural sciences are able to understand the meaninglessness of the world without turning it into yet another quest for meaning. By contrast, Brassier states, 'I am very wary of "aesthetics": the term is contaminated by notions of "experience" that I find deeply problematic. I have no philosophy of art worth speaking of. This is not to dismiss art's relevance for philosophy but merely to express reservations about the kind of philosophical aestheticism which seems to want to hold up "aesthetic experience" as a new sort of cognitive paradigm, wherein the Modern (post-Cartesian) "rift" between knowing and feeling would be overcome' (Brassier/Ieven 2009). But if the intention, as Brassier explains, is not to banish art's relevance for philosophy, what then, we might ask, is art's role within the new meaningless nonhuman order of the real? How can we conceptualise a politics of the aesthetic that is more than the mere tracing of art within philosophy and likewise of art understood as a lesser form of philosophy? The challenge, I think, is twofold: how to ensure that art and aesthetics find an adequate, even dynamic, place in non-correlationist, nonhuman-oriented theory, without privileging human experience (thereby falling back on the old anthropocentric perspective), but also without completely exterminating relationality, as is the tendency in speculative realism.

What might constitute our entry point to an otherworldly aesthetics that might have something to say about this world? The notion of an unspecified, amodal, peripheral aesthetics, as Ergenzinger's *Navigating Noise* demonstrates, seems endemically sonic. As you stand in the space of the installation, underneath the noisy sculpture, it becomes clear that there is always more in the sonic than meets the ear. *Navigating Noise* works with invisible vibrational forces that bring forth a barely perceptible yet resonant audio dimension that challenges the centrality of human perception in art. The artwork 'detects the visitor's presence and translates [her] movements into changing acoustic fields' (Ergenzinger, nodegree.de), rather than the other way around. The situation the project effectuates can be thought of as a virtual container for the potential relations between body, space, sound, and machine, from the standpoint of the anorganic. In its murky zones, a mode of virtuality begins to emerge that is real yet too fleeting to be immediately perceived by the senses. The idea is that the way a body feels spacetime through sound pushes it to encounter an alternative mode of perception. Sound, it could be suggested by this artwork, offers one way out of the binary dichotomies between nature and culture, material and immaterial strata, human and machine entities. This is because in the sphere of the sonic event, our traditional notions of what it is to be human, what constitutes consciousness, our existing aesthetic models, the boundaries between concreteness and abstraction, and more, all become unstable and uncertain. So what are the theoretical implications of taking an intervention like Erzenzinger's as seriously as a work of art deserves to be taken? What might this particular project have to tell us about the sonic and what it can do?

Different writers have engineered different conceptual approaches to capture the significance of the sonic; nevertheless, the majority of sound studies seems to focus on our connections with and experience of the auditory world – accounting for the hearer, the instrumentalist, the act of deep listening, and the creative possibilities of the soundscape. Many of these accounts have developed as a way of making sense of massive changes in culture and technology from an explicitly sonic standpoint. They constitute reactions to the primacy of Cartesian reason, showing ways of escaping the Western tendency to measure, calculate, and represent everything. They offer strategies for defending and resurrecting the nullified senses, such as hearing, which must no longer surrender to the tyranny of ocularcentrism. However, we can identify two restrictive tendencies here. Firstly, sonic fetishism, i.e. the rejection of the dominance of vision in favour of a problematic exoticisation of the oral/aural others (e.g. McLuhan and Ong). This dubious metaphysical pattern has been critiqued by Jonathan Sterne (2003) as the 'audiovisual litany'. Secondly, refreshing as they might be, these accounts don't seem able to completely do away with a human-centred position. In fact, most of the literature that I'm aware of remains firmly positioned in a phenomenal experience of sound, dealing with human subjects, their consciousness, intention, attention, and reflection on the sonic object or event.

This is not to say that there haven't been other schemas daring to go beyond the audiophile angle. Relevant here is Casey O'Callaghan's (2010) argument for a sonic realism, theorising sounds as independent of their sources and events, that is, as things in themselves. Here, sounds are not reducible to secondary qualities (like colours or taste) that are relative to the observer, or to the properties of the medium through which they become audible (e.g. air), or to subjective sensation. Influenced by the mission and methods of speculative realism, O'Callaghan draws on scientific discourse, particularly on physics and psychophysics, to show that sounds

are autonomous entities, ontological particulars as temporal events. For him, sound events are ontologically nothing short of 'complex individuals'. Another example aiming to push sound studies to a more exciting place is Will Schrimshaw's (2013) suggestion to abandon the dominant narratives of interiority and immersion, used to describe sonic experience, and turn towards a practice that treats the aesthetic as immanence. Schrimshaw highlights the need for sound theory to move away from the various phenomenological, correlational, and mystical positions that support the predominance of the immersive and for attaining greater conceptual potency and epistemological efficacy within the sonic arts. The angle here, again, is repositioning sound after existing critiques of correlationism, mainly by Meillassoux and Brassier, by disentangling the concepts of immersion and immanence.[3]

3
'Correlationism' is a term conceived by Meillassoux to describe mainstream Western philosophy's claim (since Kant) that the world can only be accessed through the experiential. The implication here is that, for this reason, our grasp of reality and our idea of it is always dependent on our sensory perceptual structures and, thus, that the processes of thinking and feeling cannot be separated.

Schrimshaw's problem is, following Brassier, what he sees as the privileging of relationality contaminating sound studies, whereas O'Callaghan draws on empirical research to account for the 'nature of sounds' as distinct objects, in a manner that often, intentionally or not, is reminiscent of the inner life of objects in Graham Harman's ontology. Harman privileges the aesthetic in thinking speculatively about reality, informing us that 'aesthetics becomes first philosophy' (2007, 221). He proposes a non-correlationist, nonhuman-centred metaphysics, one in which 'humans have no privilege at all', so that 'we can speak in the same way of the relation between humans and what they see and that between hailstones and tar' (Harman 2009, 124). As Steven Shaviro (2011) has already explained, such a non-relational ontology fails to grasp and account for change and process (that is, for becoming) in 21st-century life. Comparing and contrasting Harman's substance-based philosophy with Whitehead's thought, Shaviro explains that, on the one hand, they both construct a speculative philosophy that privileges aesthetics over both ethics and epistemology. On the other hand, he posits, Whitehead's emphasis on beauty – 'as a matter of differences that are conciliated, adapted to one another, and "interwoven in patterned contrasts"' (Shaviro 2011, 289) – is more useful to us today than Harman's theory of 'allure', which links him to the 'sublime' and hence to a

now long-familiar tradition of aesthetic modernism.

This is because, as Shaviro identifies, we are 'at the beginning of a major aesthetic revaluation' (ibid), owing not least to our new complex technological reality, where 'nothing is hidden' and there are no more concealed depths, as Harman would have it, pointing to the secret inner life of objects. There is indeed, as Shaviro clarifies, 'always something that doesn't get carried over, something that doesn't get translated or expressed. But the reason for this is not that entities somehow subsist beyond relation, locked into their own vacuum bubble' (ibid, 285). Rather, 'every actual entity is present in every other actual entity', each 'self-creating' and 'self-subsisting', yet they continually 'affect, touch and interpenetrate one another' (ibid, 289). For Shaviro, our predominant computational aesthetics of sampling, synthesizing, and remixing – also native to the sonic – and our massive accumulation of already-existing, recycled, electronic material demand a Whiteheadian philosophy of aesthetics, one concerned with both transience and futurity (what Whitehead calls 'creative advance') and able to account for properties that are 'real, without being actual' in a no longer human-centred world. Crucially, as Shaviro tells us, an object's being affected by another need not have anything to do with knowledge at all. 'Conscious knowledge' is not involved in most interactions among entities; as he says, drawing from Whitehead again, 'I am touched and moved by things without necessarily understanding them and even when they are not in themselves "accessible to thought"' (ibid).

For a sonic aesthetics to come

Like Shaviro, I'm not entirely convinced by the eagerness to get rid of relationality, especially when it comes to sonic aesthetics. Relations in Deleuze, Whitehead, Simondon, William James, and Susanne Langer, to name a few, are not about the inability of a thing to exist outside of how it is thought about by a human, but about the 'mixing of humans and nonhumans'. To quote Shaviro again, 'All actual entities are ontologically equal, because they all enter into the same

sorts of relations' (ibid, 281). Equally, I wonder if there might be a way of conceptualising sound events without regressing to the enclosure of things in the form of inaccessible substances (i.e. a realm that is by default inaccessible to perception), while simultaneously rejecting and misunderstanding the philosophies of potentiality and virtuality. Sounds as actual entities disconnected from everything else seems to be a one-dimensional way of thinking about events that underestimates the importance of change, transience, futurity, and relationality and condemns things to an uninteresting withdrawal. As *Navigating Noise* seems to hint at, it is in exposing a middle realm of heterogeneous elements in constant flux that the sonic artwork becomes intriguing. Ergenzinger's project operates on a plain that is as much artistic as it is scientific, a simultaneously aesthetic and physical experiment, and it seems to me that intersections between these spheres might be better equipped to account for the importance of novelty and vividness of change over time. The recent attempts at the construction of a new sonic philosophy are a welcome turn away from the fetishism, ideology, and monotony of sound studies. However, in their efforts to plug sonic thought into the neo-rationalist machine, they leave us with another gap: that is, they fail to account for the experience of the potential, that which we cannot directly relate to but which exposes us to the non-humanly dimensions of the real. That which reveals aesthetic experience as a rupture in time, a moment of potential where the entities involved (humans, artworks, etc.) can be any thing whatsoever.

Perhaps closer to helping us formulate an otherworldly sonic theory is Kodwo Eshun's 1998 book *More Brilliant Than the Sun*, which sets the stage for engineering a minoritarian audiovisual aesthetics. The book is a machine for pushing, stretching, reversing, and mutating music events towards new levels of sonic potential. It presents a non-compiled profusion of names, tracks, sounds, lyrics, and sleevenotes, not as historical artefacts but as audiovisual vectors with the capacity to acquire a new function. As the author explains, it is born out of a time at the end of the 20th century, when 'music today is already *more* conceptual than [it has ever been], pregnant with

thoughtprobes waiting to be activated, switched on, misused' (Eshun 1998, -3). *More Brilliant* unleashes the unknowable logic of sonic fiction. This, according to Eshun, is 'speculative theory embedded in science fiction, science fiction reinterpreted as an analysis of the ongoing present, adding to that the extraction of concepts and using them as vehicles to get to somewhere new' (Eshun/Lovink 2004, 351). It is an unconventional research method whose aim is to radicalise the speculative ghost in contemporary sound culture. If we accept that speculative thought and computational media have been a productive pair across cultural theory, technoculture, and cyberstudies, at least since the mid-nineties, then the sonic element would seem to fit and intensify the assemblage in promising ways. The virtualisation of sound culture builds on the pre-existing world of the avant-garde and on the DIY culture of the PC as music studio, but pushes them further and goes beyond both (Goodman 2010). It involves mobilising new levels of possibility space, invites concept manufacture, spawns new languages, and demonstrates, as Kodwo Eshun puts it, 'an extreme indifference towards the human' (1998, -5).

Intertwined with the power of fictional spaces to simultaneously discover and invent truth, sonic – or phono – fiction surpasses the limits of human knowledge by directly tapping into the artefacts and events rather than settling for their cultural analysis. For Eshun, the idea is that the sonic book 'does not have to be historical. It could be a sonology of history; [not] a contextualisation of sound … [but] the generative principle … generat[ing] its own life forms, its own worldview, its own world audition' (Eshun/Lovink 2004, 351). In other words, sonic fiction is indifferent to the logic of applying philosophy to read culture, and it ignores the tradition of historicising the old methods. Such an extra-auditory way of thinking is useful for unearthing aesthetics from the virtual sphere of sound and for suggesting that reality – and philosophy – can be excavated from fiction. Prioritising the nonsensuous vibrationality and rhythmicity of events, prior to and independent of our understanding of them, is a testament to the ways in which sonic thought and art strive to scout out something that runs

counter to the normal order of things, and out of which new configurations emerge. This is 'theory under the dominion of sonic affect; sound coming to the rescue of thought, rather than the other way around, forcing it to vibrate' (Goodman 2010, 82). Such an unearthly sono-aesthetics pushes theory toward the vicinity of a more 'unreal state', where the boundaries between fiction, science, art, and philosophy are provisional and utterly permeable.

Unidentified sono-aesthetics

Sono-fiction allows us to consider the aesthetic, the conceptual, and the fictional as dimensions of the real, on an equal footing with everything else. It exposes the aesthetic as productive of reality, activating a continual intersection between creativity and experiment, fiction and fact. Such an approach to aesthetics reminds us that every field's approach to the real, whatever the intention, is always, following Stengers again, a collective and passionate process that presupposes each proposition by daring to ask 'what if?'. A question put forward by a theory of aesthetics interested in radicalising speculation might be: What if speculating, imagining, and even dreaming might serve as a means for the discovery of truths? What if the quest for truth necessarily entails a spiritual dimension, in the sense that Foucault gives to this term? As physicist and philosopher Gabriel Catren (2015) notes, Foucault understood the relationship between the subject and the truth through a predominantly 'spiritual' framework; stating that 'we could call "spirituality" the search, practice and experience through which the subject carries out the necessary transformations on himself in order to have access to the truth. We will call "spirituality" then the set of the researches, practices, and experiences, which may be purifications, ascetic exercises, renunciations, conversion of looking, modifications of existence, etc. which are, not for knowledge but for the subject, for the subject's very being, the price to be paid for access to the truth' (Foucault 2005, 16–17). For Catren, what is of utmost importance is the problem of clarifying the links between philosophy and what he refers to as 'local or abstract modes of thought (such as the sciences, the arts and politics)'

(2015, 75), which are always a product of the impersonal field of experience. The question, for him, is how we might 'be able to jump over our own shadows, i.e. to perform transcendental variations enabling us to have phenoumenological experiences' (ibid, 67). Against the split between the 'superior' noumena and the 'inferior' phenomena, Catren quotes the term 'phenoumenological experience' which 'entails by definition a speculative transcendence that goes "beyond" the transcendental fixity of the limits of human experience' (ibid).

Returning to Shaviro, as he shows, there is a 'sensibility without knowledge and without phenomenological intentionality' (2014, 147). For him, 'aesthetic contact happens in the first instance outside knowledge, on a level beneath the threshold of conscious perception or beyond its capacities to recognise or relate. Outside of any correlation of "subject" and "object", or "knower" and "known", an occult process of influence is already taking place' (ibid, 148). The occult aesthetic of the sonic is plugged into a realm at once relational and non-correlational, real yet unknowable. A realm of 'immanent noncognitive contact', 'situated before – or on the hither side – of knowledge', 'a movement that comes before the correlation of mind and being and of subject and object' (ibid). A subjectless aesthetics that cannot be tied down to the particular object, artwork, situation, or body by which it is apprehended. This is a resonant, autonomous middle zone, a force activated by the encounters of things rather than belonging to somebody's intentions or being about something in particular. There is a sense in which the artwork 'touches and changes us in ways that we cannot know, or that become cognizant retroactively – i.e. indirectly, nonconsciously, having a "basically ineffable effect on us"' (ibid), as Harman postulates. For Shaviro, the aesthetic dimension is irreducible for a politics of speculation, which requires new, bold inventions rather than pacifying resolutions such as Meillassoux's (aforementioned through the notion of correlationism) vision of radical contingency or Harman's vision of objects encased in immutable vacuums. As he notes, 'such a speculative aesthetics is still to be constructed' (ibid, 156). However, for me, the importance of Shaviro's and Eshun's writings, among others,

lies in affirming that not only is there a place for aesthetics in devising alternative theories and methodologies today, but, crucially, by plugging into the sonic, it might be put to use as a form of re-orientation proper to the study of the present.

As J. G. Ballard teaches us, the present is yielding every possibility, and therefore studying it must necessarily involve the recognition of what is real without being actual, simultaneously of this world and alien, radically different to us and therefore unknowable.[4] After all, aesthetic response, as Robin Mackay notices with his notion of unconscious premammalian experience, is 'a matter of navigation within a memory bank of experiences the subject never had' (2014, 100). Attempts, then, to hatch an alternative theory of sono-aesthetics might also echo the reconfiguration of researching by drawing a line of flight from the known towards the unknown, rather than the other way around; taking unknowing as a serious method of inquiry. Sono-aesthetics presupposes a rupture to knowledge and the opening up of experience to a nonhuman realm. As Michel Serres puts it: 'One writes initially through a wave of music, a groundswell that comes from the background noise, from the whole body, maybe, and maybe from the depths of the world or through the front door, or from our latest loves, carrying its complicated rhythm, its simple beat, its melodic line, a sweet wafting. A broken fall. One cannot grip one's pen but this thing, which does not yet have a word, takes off' (1995, 138).

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As J. G. Ballard notes, 'Everything is becoming science fiction. From the margins of an almost invisible literature has sprung the intact reality of the 20th century' (1971), available online at http://www.jgballard.ca/non_fiction/jgb_fictions.html.

To sum up, drawing on thinkers such as Catren, Eshun, Shaviro, Stengers, Whitehead, Deleuze and Guattari, but also female thinkers not analysed here but imperative contemporaries of these ideas, such as Karen Barad, Luciana Parisi, and Rosi Braidotti, and artists such as Kerstin Ergenzinger, a speculative sono-aesthetics theory begins to emerge. In the process, 'the possibility of attuning the resolution of sensibility (both perceptive and affective)' (Catren 2015, 4) to unknown spatiotemporalities, begins to take shape. To put it differently, a new sono-aesthetics can allow us to account for a sonic event, such as *Navigating Noise*, as able to express the memory of an unlived reality, arriving entire and intact to us,

yet never before experienced. The sonic artist might not be the only one able to remember a different spectral present but she is willing to talk about it. As Brian Massumi proposes, 'It is in this sense that an artwork is creative: in the manner in which it potentially invents new passions and tendencies. It is not the artist who is creative. Creativity is not a subjective state. It is a manner of activity, passing through the life of the artist' (2011, 122).

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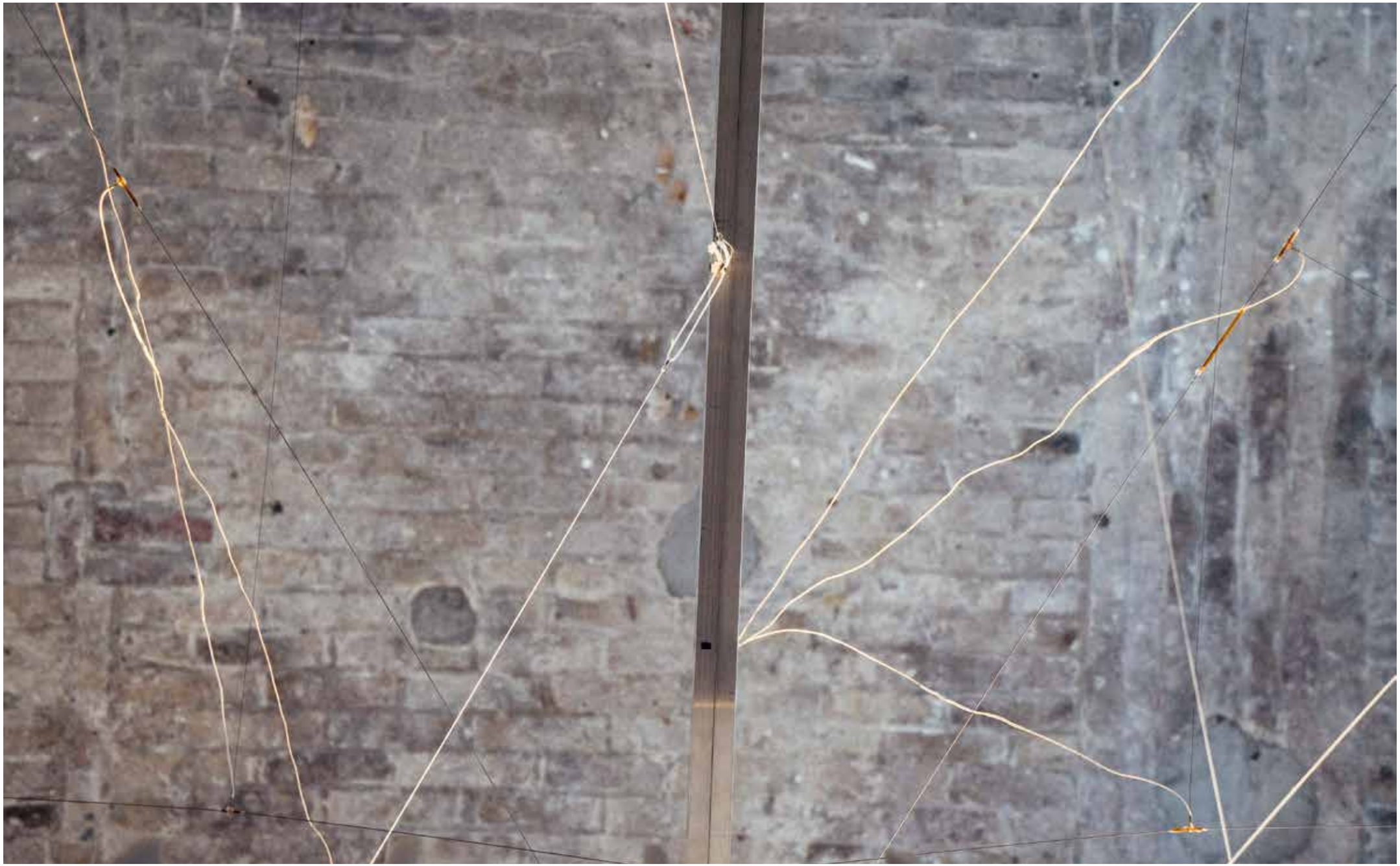
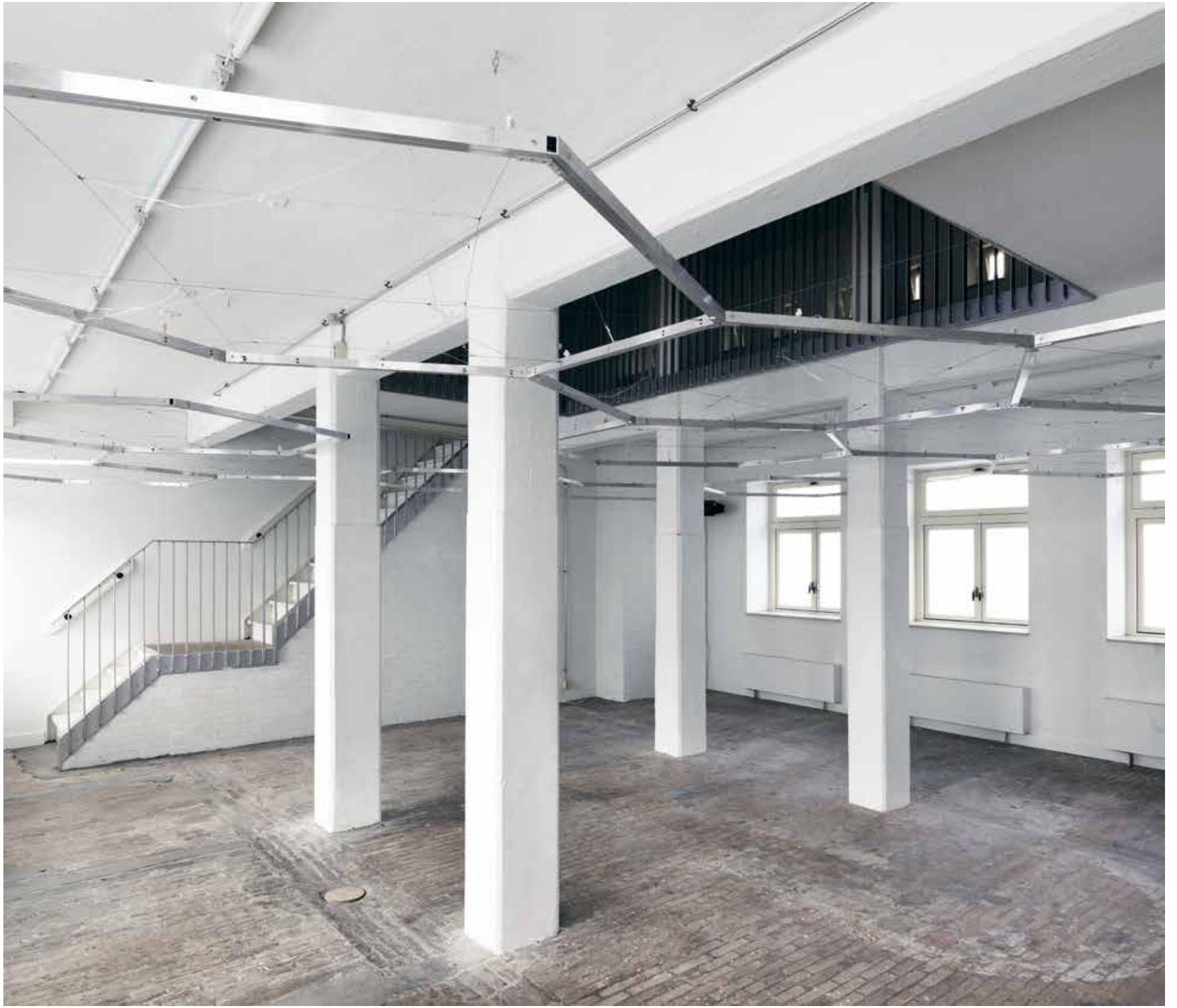
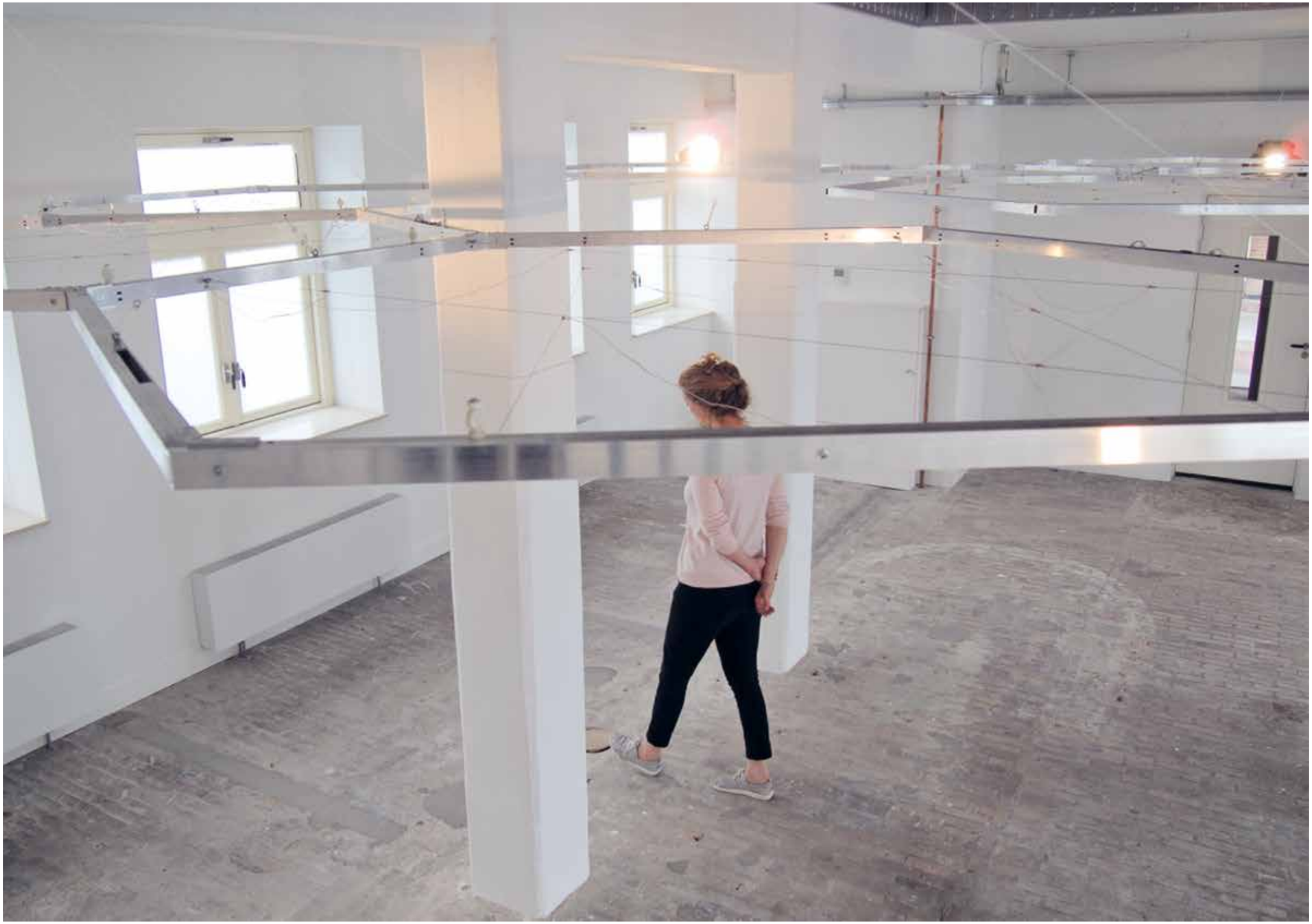
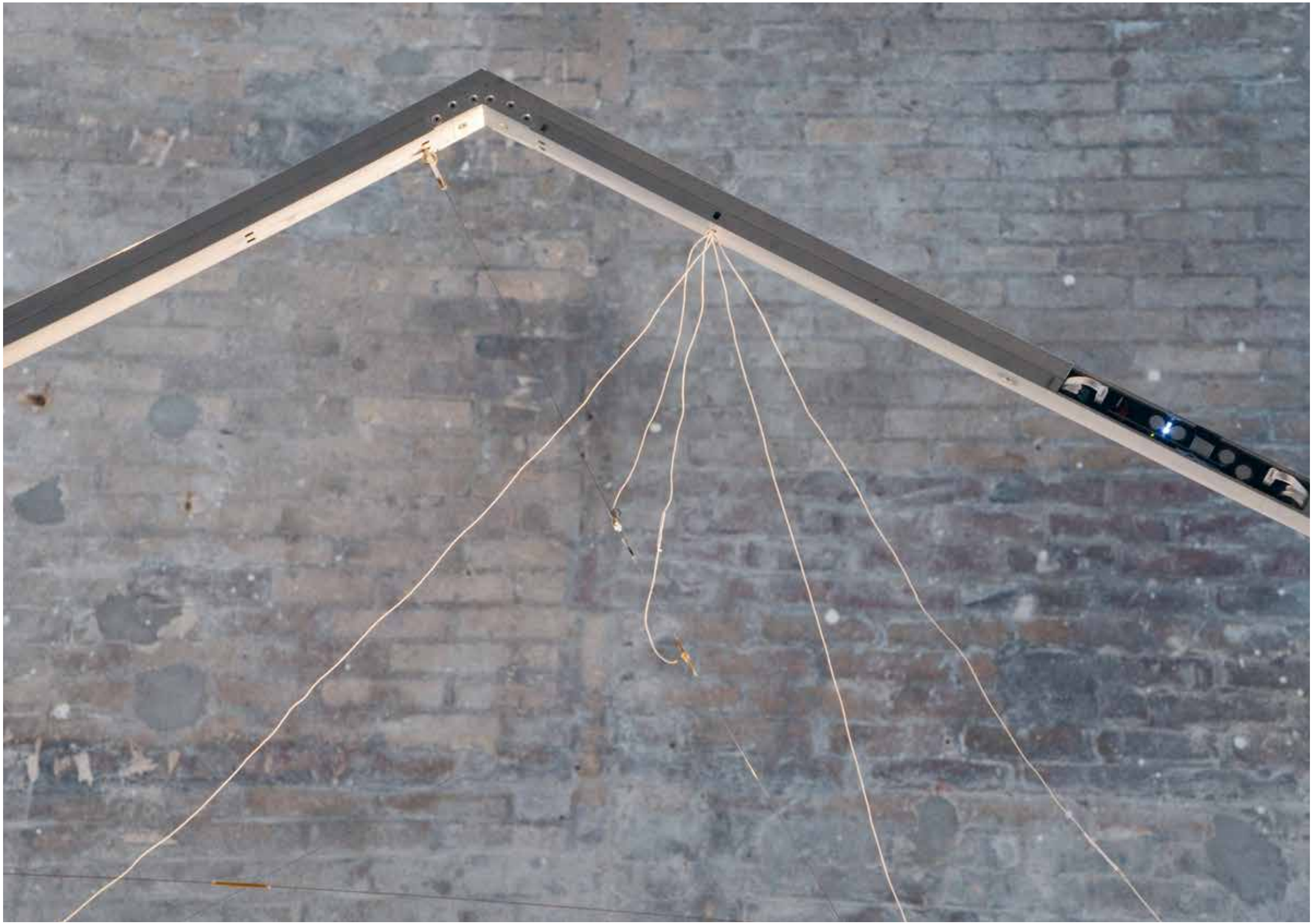


Kerstin Ergenzinger, *Navigating Noise*.







THE SONIC

What Does It Mean to Think Sonically?

Contours of Noise as a Sonic Figure of Thought

Felix Gerloff &
Sebastian Schwesinger

168.

Sound is never simply sound but always culturally induced, informed, and formatted. Much of the work in contemporary sound studies has pursued the analysis of the historical meanings with which sound was imbued or of implicit auditory knowledge. A complementary strand of research is inversely tackling the epistemic productivity of sound within culture.[1] Guiding research questions such as 'How are sounds and listening constituted culturally?' or 'What cultural meanings do sounds incorporate?' are accompanied by reciprocal inquiries: 'How is culture constituted sonically?' or 'In what ways are perception, thinking, and epistemic practices informed by sound?' While sound serves as an abstract term for a physical as well as trivial description of acoustic vibrations, German scholars have proposed the term *das Sonische*, 'the sonic', as a more precise take on historical cultivations of sound in music, media, or human corporeality. We believe that this concept may serve as a viable vehicle for thinking about these chiastic vectors of entanglements of sound and culture together, without privileging one over the other.

The notion of the sonic was outlined in 2008 in the German academic journal *PopScriptum*, which tried to rethink the 'methodic distinction between "Schall" (sound as physical phenomena), "Klang" (sound/sonority), and "Musik" (music) for the analysis of popular music' (Papenburg 2008)[2]:

'The sonic is then culturalized acoustic matter – or, in other words: the concept of sound that is linked to the respective modes of sound generation and its technology, as well as to the soundscapes (Schafer 1980) of a particular time and society. This is inscribed into the instruments of sound generation just as it is into the modes of music making – although this level goes far beyond music and makes it much more identifiable as an integral component of a society's audio culture' (Wicke 2016, 27).[3]

Constitutive elements of the sonic as an explicitly holistic approach to sound include its technological media, its spatial

1 For the first strand, see the work of historians on the cultural and media history of sound, such as Karin Bijsterveld (2008), Emily Thompson (2002), Hillel Schwartz (2011), Jonathan Sterne (2003). For the latter strand of research that tries to reconstruct human thinking conditioned by sound, see Veit Erlmann's work on 'Descartes's Resonant Subject' (2011) or Jacques Attali's (2011) work on the history of the distinction between noise and music heralding upcoming economic and societal order.

2 Translation provided by the authors.

3 This notion has only recently attracted some international attention. See, for instance, the translation of Peter Wicke (2016). Wolfgang Ernst extensively uses the concept of the sonic in his latest publication (2016).

situatedness and atmospheric manifestation, and the shape it is given by specific practices – in this original context, the practices of making music. In his editorial foreword, Jens Papenburg positions the sonic between physical sound and discursively constituted music. Technical formattings of sound – including scores as well as tracks in the realm of music – serve as mediations between these heuristically separated spheres. In relation to perception, aesthetics as aisthesis, Papenburg believes the sonic is heard with a schooled ear, actualising culturally memorised and embodied patterns between physical hearing and conscious, active listening (Papenburg 2008).

As we understand it, the sonic informs a material-symbolic nexus that allows for the analysis of auditory culture between a scientifically objectified physicality of sound and the individual corporealities of hearing and listening. We propose an expansion of perspective to consider the sonic not only as an integral component of audio culture, as Wicke and Papenburg frame it, but also of other 'sense-culture[s]/*Sinnkultur*[*en*]' (Hörl 2013, 124). After all, the sonic might best be characterised as providing a historically specific framework for thinking that allows its constituents to trespass the borders of auditory cultures and reverberate throughout all spheres of cultural (not only human) activity. In this vein, the understanding of the sonic as a cultural formatting of sound can be extended through an empirically thorough analysis of its specific appearances and efficacies as it resonates within various dimensions of culture, such as media and technology, bodies and environments, music and arts, or economy and society. As others have sporadically hinted at, we suggest heuristically specifying these relational and operative instances of the sonic as, e.g., the musico-sonic, techno-sonic, discurso-sonic, etc.[4] These contexts of sonic cultivation are then to be investigated in their configurations of knowledge and power, i.e. cultural formation, within a dispositive-analytical approach that allows for the consideration and relational assessment of historically relevant cultural elements and dimensions of the most diverse fields – *sonically thinking* together the material and the symbolic, non-discursive and discursive practices as intrinsically related modalities of cultural processes.

4 Jacob Smith coined the term 'eco-sonic' (2015), Douglas Kahn introduced the notion of 'aelectrosonic' (2013), and Wolfgang Ernst recently used 'technosonic' (2016).

Notions such as noise as well as music, harmony, or resonance may be understood as historical instantiations and specifications of the sonic which are not determined in isolation but equiprimordially. They constitute figures of thought that are deployed to make sense of the sonic and afford strategies for engaging with it – as we show in our brief analyses of dealing with urban noise in the early 20th century and with sounding atmospheric electricity in the 19th century. Moreover, they are transposed through relations of analogy and homology to other fields – much as noise became a differential category within information theory. Following this approach, we want to outline structures of sonic thinking and carve out contours of *noise as a sonic figure of thought* focusing on the two different modes of the techno-sonic and the aelectro-sonic.

Sonic epistemologies
I. Two accounts of sonic thinking

If we look into the recent past, both the linguistic turn and the pictorial turn involved more than a shift of attention towards verbal or visual impressions. They argued that our human cognitive modelling is processed in the form of language or images, and that verbal and figurative thinking are unique aspects of a human approach to the world (Rorty 1968, Bachmann-Medick 2006). It seems that, in recent years, the emerging field of sound studies has begun to reflect on 'sound as a medium' (Wicke 2016, 26) or dimension of thought as well. The conception of the sonic provided a crucial step in this direction, at least for one of the protagonists of the *PopScriptum* issue, Holger Schulze. Accounting for the situatedness of every act of listening, he later developed four central characteristics for his version of sonic thinking:

'[T]hinking sonically could be narrowed down to a process, which is:
(a) not reducible to mere alphanumeric, logocentric translations or Aufschreibesysteme (Kittler 1985). Physically inscribed and visually represented numbers, letters, words or mathematical operations are literally not what one listens to. As a consequence, sonic thinking implies a genuine sonic approach, which is
(b) not ignorant of how specific and highly dynamic spatial environments shape and condition one's experience. Sound is always experienced in particular situations, and not in abstract graphs, flowcharts or statistical distributions.
This sonic way of thinking, moreover, should
(c) not ignore the fundamentally corporeal character of auditory experiences for anthropoids (as the factual main listeners in research), because their bodies are in fact their primary and very material receivers, amplifiers and interpreters of sound.
Finally, sonic thinking should
(d) not be ignorant of the imagination and its sensorial and proprioceptive aspects - as sound resonates with the entire anthropoid's body, whose various senses are not too easily separated from one another' (Schulze 2017, 219–220).

In contrast to a logocentric and representational analysis of sound, Schulze stresses concrete listening situations and practices which depend largely on an interplay of spatial, corporeal, and imaginative factors. Such a perceptual model is still relatable to another 'anthropoid's', group's or its own *sonic persona* which is 'shaped and constituted by the sonically perceptive, performatively generated traces that any vibrating entity leaves in a specific cultural and historical era as well as in a situational sonic environment' (Schulze 2014, 167–168). Sonic thinking therefore relates to a specific and yet under-theorised mode of auditory perception and cognition. Although much of the research within sound studies has been devoted to excavating such ways of knowing that are implicit in listening, it has seldom led to a more general take on sonic epistemology. Jonathan Sterne's pronounced and resounding criticism of the so-called 'audiovisual litany' justifiably faulted the theoretical implications that a separation of the senses (e.g. vision/seeing and audition/listening) invokes and thereby also strongly supported the deconstruction of dubious hierarchies of the senses (Sterne 2003, 15). However, this argument for a cultural construction of the senses and their abilities seems to have restrained thinking about specific conceptions of sonic models of perception and cognition. Anahid

Kassabian's influential study of ubiquitous music surrounding us in contemporary everyday life is – alongside Holger Schulze – another exception. With regard to the inattentive listening that happens constantly, and investigating musical functions such as mood modulation, marketing, and the design of atmospheres in public buildings, Kassabian analyses the effects that this ubiquitous listening has and how people engage with this kind of music and sound. As a result of this permanent co-presence with music, a *distributed subjectivity* emerges in which the specific models of the sonic inscribe themselves in and structure the listening spaces and subjects (Kassabian 2013). Both the *sonic persona* and the model of *distributed subjectivity* can be regarded as constituting a different mode of approaching the world modelled through listening practice. They widen the notion of sound to include situational perceptual qualities and thus organise a phenomenological as well as environmental analysis of listening, culminating in anthropological accounts of knowing.

From a very different perspective, art philosopher Christoph Cox also explicitly argues for a materialistic concept of sonic thinking. He developed his call for a sonic materialism in concordance with Casey O'Callaghan's philosophy of sounds and auditory experience and has been mainly concerned with sound art (Cox 2011, O'Callaghan 2007, Schrimshaw 2013). In his conception of sonic thinking, he asks: 'What concepts of thought can sound itself generate?' (Cox 2015, 123). In contrast to the approaches of Kassabian and Schulze, he considers sounds as particular entities in their own right and thus aspires to overcome solid object ontologies with which philosophy has been erroneously preoccupied until now. Therefore, while matter is generally associated with tangible physical objects, the 'invisible, intangible, and ephemeral objects (so to speak) of smell, taste, and hearing seem to have only a shadowy existence' (Cox 2015, 124). But, of course, sounds also exist in this material sense and can, therefore, serve as an alternative basis for ontology and for a different materialism.[5] Accounting for sound art that has built upon a powerful physicality of sound instead of notated musical operations and their hermeneutical interpretations for sense production – which

5 It needs to be asked whether a general opposition between object ontology (of being) and process ontology (of becoming) exists in such a way and can further be underscored and correlated with their supposed sensate orientation towards vision and sound, respectively, or whether such systematic shortcuts harness – referring to Sterne – a *litany of the alternative*.

aligns with Holger Schulze's distinction between perceived sound and its inscribed representations – Cox observes an ontology of flux in which sounds are energetic forces that have to be considered real and mind-independent.

'Sounds persist in time and survive changes to their properties and qualities. Thus, they can't be treated as secondary qualities (such as colors or tastes) that are relative to their observers; nor are they the properties of their sources, which cause or generate them but nonetheless remain distinct and separate. In short, sounds are not tied to objects or minds but are independently existing entities' (Cox 2015, 126).

In this way, a sonic effect becomes separable from its cause. Even though sounds are the results of physical actuators, they do fundamentally differ from them. Cox refers to the audio effects used in studio productions or generated by Foley artists as instances in which sounds live a life of their own. Such effects obfuscate their sources and are implemented into effects units which make them addressable or even usable as signatures in totally different circumstances (e.g. digital sound design). In an attempt to catch up theoretically with sound practice and to develop a more general sonic philosophy from this departure point, Cox argues for a process philosophy that defines seemingly stable agents and objects as temporary bundles of flows of energy. Sonic thinking appears as a form of sonic ontology for which he only vaguely outlines a methodological suggestion.

'To think in this way is to refuse the idealist enterprise that consists in imposing philosophical concepts onto the real, subordinating the real to a set of formal syntheses taken to be ontologically distinct from it. Instead, sonic thought follows the flows of matter and energy that constitute the real, producing concepts that are themselves instances of the syntheses by which the real articulates itself' (Cox 2015, 129).

Drawing heavily on materialist thought in such a seemingly ontological way while deploying an apparently physics-related vocabulary poses the threat of ignoring the genealogies of

situational and cultural diversities in which sounds are generated, processed, and perceived. Although sounds do obtain physical and semiotic coherence in specific configurations, it is difficult to imagine these material fluxes as being distinct from a network of meanings that is technically, discursively, or otherwise shaping and being shaped by its operating entities.[6]

6 Both Schulze and Cox have put forward their arguments in the recently edited volume *Sonic Thinking* from Bernd Herzogenrath (2017). In the introduction, Herzogenrath provides his own account of sonic thinking, which uses some elements of both authors to highlight the materially based and practically rendered forms of knowledge of sound artworks that facilitate 'comprehension of the world [...] beyond the aesthetic experience' (2017, 6).

II. Sonic thinking in dispositives

Bringing the concept of the sonic back into the discussion on sonic thinking, one could reap the benefits of both of these differing approaches. Both listening practices and sound flows occur in formattings of the sonic as mediality and predisposition of cultural generativity and meaning production. In *discourses*, notions of sound can be analysed and applied in terms of their epistemic qualities of conceptualising the relations between or statuses of 'things' – see, for instance, productive figures of thought such as noise, harmony, and resonance. Sonic thinking can also direct attention towards our physiological, mental, and imaginative processing of sound as a perceived phenomenon, understanding *corporeality* as a dimension of the sonic. Similarly, *spatial* and situative dispositions of sounding and hearing/listening contribute to the articulation of sonic insight. Sound *media* has implemented meaningful signalling protocols that use qualities of sound to transmit, process, or store contents or purposes, thereby collaborating in our epistemic processes. In *scientific epistemology* in particular, sound has been used to impart information about biological or physical systems following standardised regimes of signification, such as in auscultation, acoustics, and phonetics. Many of these instances of sonic thinking fundamentally draw on *music*, the field which spawned the concept of the sonic. The production, appreciation, and subsequent analysis of music have historically yielded sonic epistemic tools such as the aforementioned concepts of harmony, resonance, and rhythm. Music has been a driving force behind the emergence of physical acoustics and the development of an aesthetic understanding of sounds as potentially abstract, at least in the European tradition. Musical tonal systems that have themselves been influenced by discursive consolidations

or technical innovations, for instance, still serve as an epistemological background, as a prominent condition for the possibility of hearing specific auditory events as tones, noises, or timbres and deploying them, moreover, in more utilitarian contexts such as functional sounds and signals or sonifications.

What links all of these different forms of sonic meaning and knowledge production is their embeddedness in dispositive structures.[7] According to Foucault's notion of the *dispositif*, all expressions and manifestations that are produced within a certain epistemic ensemble of apparatuses, juridical orders, infrastructural configurations, discourses, bodily imaginations, etc. delineate the field of possible knowledge and thinking and should be taken into account accordingly (Foucault 1978). In addition to his previous discourse analysis, non-discursive practices are added to the scope of what is to be analysed. Within such a methodological approach, the non-sound dispositions often provide form and context for sonic events to make them effective and meaningful. Following precise chains of sonic 'transpositions' (Kittler 1990, 265–266) through physical and technical properties, cultural semantics, bodily perceptions and affects, and renderings in text or speech, the important characteristics of specific historical models of the sonic can be determined by crossing construed boundaries between listening and sounding, subject and object, or practice and process. The sonic in this way is always historically contingent within its dispositives. Consequently, there can be no ontological definition of sound, but an always context-dependent blending of its physical properties with its cultural, technological, or practical predispositions. The sonic can be described as a multi-faceted operator of cultural formations, an abstract cultural protocol and formatting – producing differentiations and characterisations suitable to provide affordances for meaningful and effective instantiations of 'sound'.

7 This approach follows the basic line of thinking of recent culture and media studies research into cultural techniques, in which the specific conditions of 'sense production' (Siegert 2011, 14) are analysed. Cultural media and techniques are investigated as a nexus of material and semiotic practices that generate, mediate, and process cohesive 'sense-culture[s]' (Hörl 2013, 124).

Investigating sonic phenomena within their cultural dispositions and actualisations falls in line with a media ecological approach such as the one identified by Erich Hörl for contemporary (media theoretical) thought. The kind of general ecology of thought that he describes relies on a

general mediation that is emerging through the technological condition of our times. It favours relational thinking and processuality over entities and objects. Hörl envisions a new 'sense-culture' emerging out of this mode of thought – a 'sense-culture' that might be complemented by sonic thinking as well (Hörl 2013, 124-128). Dispositive-analytical investigations of sonic thinking in analysis and experimental explorations[8] endeavour to precisely identify the ways in which the sonic, in its various manifestations, pragmatically contributes to epistemic processes. What are the specific epistemic modellings of the sonic that co-evolved with dispositive structures? How is sonic reasoning transposed into further realms of culture beyond audible phenomena like discourses, technologies, or formalised systems of knowledge production such as in scientific sonification? If sounds cannot be reduced to alphanumeric, logocentric inscription systems, as Holger Schulze forcefully claims, how can sonic epistemic processes that nonetheless inform thinking and culture – i.e. what is knowable and expressible – be analysed and described with due specificity as regards their semiotic, meaning-producing aspects? What might the sonic equivalent be to a diagrammatics of knowledge and insight, what might a truly sonic logic sound like? How much would conceptualising reasoning, semiotics, and epistemology sonically rework our understanding of these practices and registers? Such questions draw attention to notions of (symbolic) form, structure, figure of thought, epistemic models that might heuristically lend coherence to the sonic in its processual traversing of cultural dimensions such as the audible, media technologies, discourses, bodies, etc. Investigating operations of navigating noise from many angles in this sense may provide the preliminary contours of noise as a sonic figure of thought and, by extension, a deeper understanding of cultural reverberations and specific workings of (the) sonic (&) thinking.

8
Such explorations include artistic works such as Kerstin Ergenzinger's installation *Navigating Noise*, which prompted the discussion that led to this publication, and the development of scientific audio formats such as audio papers (Krogh Groth/Samson 2016, Gerloff/Schwesinger 2016).

Noise as a sonic figure of thought
I. Techno-sonic noise

Applying sonic thinking to domains other than music, we can infer that, in each context, a specific formation of the sonic may be identified which brings to the fore applicable differentiations of what counts as music, noise, signal, or silence; deploys technological regimes of sound processing that shape the sonic materially; and facilitates a specific cultural formatting of sound that allows the existence of a repertoire of discernable sounds to be heard. To illustrate the relevance of this approach to sound, it may be helpful to think about the implications of the sonic within soundscape history and analysis. Noise as one of these differential mouldings of the sonic is historically cultivated through a specific set of qualitative descriptions, instruments of measurement, legal definitions, and a repertoire of the practices that typically produce it.

The contemporary understanding of noise in the Western world includes its measurable loudness as a main characteristic. The precondition for such an objective assessment of loudness is the existence of a measuring device and an associated unit. Drawing on Mara Mills' work, we traced this historical (trans)formation of noise in our investigation of the invention of the decibel (Mills 2011). The notion of noise shifted from a qualitative conception of being any unwanted sound to a quantitatively measurable phenomenon due to the construction of the audiometer. The audiometer itself was an interesting hybrid of otological and telephone research and engineering (Fowler/Wegel 1922). While it was first used to measure capacities of human hearing, it later became a device for measuring noise and subsequently general loudness levels in urban environments (Free 1926). Besides the shift in the notion of noise, the overarching concept of the sonic was transformed into an understanding of sound in terms of the novel unit of the decibel, formerly the transmission unit, during the late 1920s, and then propagated through the wider public culture by means of newspaper articles, early newsreels, and public demonstrations. The apparatus and unit were manifestations of a specific model of sound conditioned by technological

knowledge and practices as well as cultural deliberation and discourses, emerging from physical acoustics, telephone engineering, and otological research (Gerloff/Schwesinger 2015).

Within this historical development, the concrete media-technological configurations of the sonic play a crucial role. Thus, we are focussing here on the dimension of the techno-sonic. Media theorist Wolfgang Ernst characterises the sonic in electronic circuitry as operating between the physical acoustics of propagating pressure waves and the symbolic orders of sound, e.g. in music or sound art. He mainly theorises the sonic depending on its physical or technical embodiments and algorithmic implementations:

'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' (Ernst 2016, 25–26).

This implicit sonic – in its electronic form of analogue signal processing within the circuitry of amplifiers or public address systems, or in its computational form within digital audio workstations and computers – affords a specifically technological time-critical operativity and manipulation of sound.[9] The apparatus stores, transmits, and processes sound, thereby formatting it along its own dispositions.

In the case of the audiometer, a continuous amplification of the loudness of a test tone was initially used to measure individual capacities of hearing, from which a standardised human hearing range was derived. Deviations from 'normal' hearing have been conceived of as an impairment which, in concordance with a telephonic transmission paradigm, rendered noise as an urban *communication impairment*. To measure the buzz of a modern city, the correlation of the electric power that was used to generate the loudness of this tone made it possible to quantitatively determine the threshold where the test tone

9 In his early account of the sonic, Ernst (2008) already hinted at a distinct timing or time regime unfolding in and through audio media. In his more recent work, he orients the whole notion of the sonic towards a time-critical theoretical conception (2014, 2016).

became audible in noisy surroundings – or where the city din no longer masked or deafened the communication of urbanites (Fletcher 1923). Of course, technological apparatuses themselves are not bound to the human hearing range and can register and process variations in sound pressure with great detail. In their specific formattings of input, storage, and output for human purposes, they participate in the perceptual modelling and coding of the sonic, as Jonathan Sterne has shown for the MP3 format (Sterne 2012).

So, historically, noise as a part of the sonic was configured partially technologically through the invention of the audiometer and yielded effects such as regulatory action determining absolute quantitative limitations for noise in urban spaces, journalistic public discourses propagating quantitative values for different typical sources of noise, and an understanding of noise as the inhibition of the intelligibility of verbal speech in public space. Thus, while a quantitative measurement of noise and a related shift in its conception was facilitated by technology, the modes of existence of noise that played a part in this context also consisted of, among other things, these discourses as well as the architecturally and materially framed audible noises in the urban soundscapes themselves. This telephonic research resulted in an understanding of sonic loudness in decibels and also informed the paradigm of communication engineering 'by which all media would eventually become digital and interactive' (Mills 2011, 126). Telephone engineering would ultimately even lead to the advent of general theories of communication and information as developed by Ralph Hartley and, later on, Claude Shannon, as Mills outlines (ibid 122, 131).[10] After having been quantified and framed as the deafening inhibitor of communication in the context of the audiometer, noise migrated as a sonic figure of thought from the context of telephone cables, room and city noise, into the sphere of mathematics, where it figured as the antipode of signal and information. As much as the implicitly sonic within electronic apparatuses – variations of electric voltage – is an unheard mode of sound, mathematical renderings of frequency-based events relate to another dimension of the sonic. Ernst underlines this fundamental coupling when he states:

10 Mills elaborates this migration of the concept of noise in her book *On the Phone: Deafness and Communication Engineering* (forthcoming).

‘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’ (Ernst 2016, 23).

As this history of noise contributed to a shift in the sonic itself through a technological invention, adding a quantitative dimension to the understanding of sound, other incarnations of noise may prove valuable to identifying and unfolding other cultural modalities of the sonic in ecological, economical, or biological realms, for instance. When an acoustic phenomenon is transformed, much like noise was rendered here, into discursive meanings, as interference into protocols of technical media, or as a threshold into judgments about bodily constitutions, it organises our relationship with the ‘world’ in a material and symbolic sense beyond the act of listening, and is thus inextricably linked to human conceptual modelling (Gerloff/Schwesinger 2016). Accordingly, a set of sonic epistemic and generative models might be found and described to be effective as ways of thinking, approaching, and shaping the world in many domains.

II. Aelectro-sonic noise

While a basic understanding of the techno-sonic, in terms of electroacoustics, is fairly common in contemporary everyday life, there is another quite obscure configuration of the sonic that nonetheless inhabits a decisive position in the history of media and communications. Douglas Kahn calls it the ‘aelectro-sonic’ in his highly influential book *Earth Sound Earth Signal* (2013). What does this neologism refer to? Kahn derives it from the notion of the Aeolian – sounds produced by a transduction of the kinetic energy of wind into audible vibrations. While the transduction in this case happens within the same class of mechanical energy – what Kahn calls transduction-in-degree – the aelectro-sonic refers to a transduction of electromagnetic into acoustic energy. This would be a transduction-in-kind. The most common occurrences of the aelectro-sonic in nature are the sounds of lightning and thunder, produced by discharges of electromagnetic energy.

‘[J]ust as Aeolian sounds were produced by the wind blowing across naturally occurring rock formations and plants, not merely human-made technologies (Aeolian harps, telegraph lines), so too could the Aelectrosonic occur in the sounds of the polar auroras and atmospheric electricity high in the mountains. All that is required to transform an electrostatic or electromagnetic state to sound is the proper transducer, and transducers can be both naturally occurring and anthropic (technological)’ (Kahn 2013, 7).

Looking at the examples throughout the 19th century that Kahn collects in his chapter on the aelectro-sonic, it becomes clear that some knowledge of electricity preconditioned experiences of natural aelectro-sonic events. Most of these accounts of hearing aelectro-sonic phenomena stem from visits to mountaintops with increased atmospheric electricity, some from the desert, and others from sightings of the aurorae borealis. All kinds of noises, from subtle crackling to piercing whistling, have been documented in these multisensory situations and brought into the context of naturally occurring electric phenomena. Due to this reference and the rather uncommon nature of these sounds, they have mostly been perceived as unsettling and alarming. However, descriptions relating to familiar categories such as music or other tonal expressions such as humming served to assign them to familiar orders of sound. In both cases, these noises indicated a (hazardously) high level of supposedly electrical energy that materialised in visual, tactile, and auditory sensations. They turned into a reliable signal and thereby established an increasingly acknowledged link between electricity and sound in natural environments. Even in early accounts, people went so far as to ascribe higher amounts of electricity to certain countries because of these experiences of aelectro-sonic discharges.

This connection between geographical territories and environments with occurrences of electricity and the accompanying auditions of the aelectro-sonic was carried further when the installation of telegraphic – and later telephonic – cable networks suddenly provided a new class of anthropic, technological transducers for electromagnetic energies. While in the telegraphic regime, listening to electromagnetic forces played a rather marginal role because the technology eventually rendered communication as inscription via the telegraphic needle, the invention of the telephone and its receiver was a crucial step in transducing implicit aelectro-sonic events into explicit acoustic vibrations audible to the human ear (Kahn 2013, 7). Nevertheless, as early as 1837, the physicist Charles Grafton Page described in a letter to the editor of the *American Journal of Science* the electromagnetic or 'galvanic music' perceived in a series of laboratory experiments:

'When one or both poles of a large horse shoe magnet, are brought by the side or put astride the spiral, but not touching it, a distinct ringing is heard in the magnet, as often as the battery connexion with the spiral is made or broken by one of the wires. […] [W]hen the contact is made, the sound emitted is very feeble; when broken it may be heard at two or three feet distance' (Page 1837, 397).

Around the same time that the telegraph was introduced by Cooke and Wheatstone, this account of musical listening seems not to anticipate the forceful aelectro-sonic events that soon took place in telegraph lines and offices. During global geomagnetic storms such as those in 1859 and 1872, such high amounts of natural electromagnetic energies were picked up by the (at that time unintentional) sensing array of telegraph lines that severe damage was recorded. At the ends of long lines in particular, transmission equipment caught fire or melted, and the operators were harmed by huge electromagnetic discharges.

'The force of the currents during this storm appears to have been very great indeed, strong sparks being emitted, the greatest force being noticed at the ends of submarine cables' (Preece 1872, 254).

Eventually, the introduction of the telephone receiver rendered the hearing of aelectro-sonic interferences commonplace by the last quarter of the 19th century. C.E. McCluer, a telegraph engineer working for Western Union, developed the habit of listening to aelectro-sonic noises on the telephone line soon after its introduction in 1877. While he was aware of the effects of aurorae, he was now surprised by the continuous occurrence of such terrestrial electromagnetic interferences. What we are witnessing here is the root of the original instalment of noise as the counterpart to a communication signal due to aelectro-sonic events in the telephone context that would later become a central dichotomy informing 20th-century information theory.

Is there a change in the notion of the sonic that resembles its transformation after the introduction of the audiometer, as described above? Through accounts of sensations of aelectro-sonic events, the phenomenal reach of the sonic was expanded to include electromagnetic energies in nature. While these noises first served as indicators of possible danger in the context of expeditions and the like, aelectro-sonic transductions by telegraph and telephone lines were subsequently cultivated as epistemic devices to gain knowledge about atmospheric and meteorological processes. Registration of large-scale electromagnetic activity through these cable networks in the second half of the 19th century also laid the groundwork for an understanding of the earth as a global system – long before the popular image of the whole earth from outer space, as Kahn points out (2013, 16–17). Imagining the earth in this way – full of energetic charges, earth currents, and celestial electricity that are distributed unevenly throughout the globe – can be acknowledged as an effect of aelectro-sonic thinking. What first appeared as uncanny noises in nature turned into a meaningful manifestation of information about the earth that – still uncanny – even inscribed itself through the needles of the telegraph system. Aelectro-sonic noise as a figure of thought thus formed a modality of approaching and conceiving of the earth, its atmosphere, and territories in terms of dangerous but also potent energy levels and electric activity. Telegraph and

telephone networks, primarily developed as media of communication, were thereby also transformed into detectors – another effect of the historical cultivation of aelectro-sonic phenomena and an early case of the affordance of noise being turned into something meaningful, a stimulus of sense-making, be it in science or, later on, in experimental music.

Navigating noise with the sonic

As we have shown in these two brief sketches, a broad notion of the sonic proves beneficial for concrete analyses of historical instances of noise. This notion of the sonic is broad because it allows for the inclusion of inaudible manifestations of acoustic phenomena, be it within electronic apparatuses or atmospheric electromagnetism. Through the manoeuvre of coupling it with its complementarily important dimensions or denominators in the respective context, as for technology and (a)electromagnetism, it simultaneously becomes specific and produces an analytical benefit by highlighting the historically particular conditions that are equally formatted by sounds and listening and that format sounds and listening. The dispositive-analytical approach allows for the inclusion and assessment of very different elements that contribute to cultural processes, as we have seen in the case of the audiometer. The focus on relations of knowledge and formation that such an approach entails makes it possible to bridge such diverse realms as communication engineering, legislation, and public discourse.

The sonic is contingent within specific dispositive structures and so is noise. According to Foucault, entities that emerge in a *dispositif* are inherently tailored to serve specific challenges [French: *urgences*] that led to the formation of the dispositive structures. In this sense, the sonic highlights the modelling character of a specific concept of sound. Likewise, noise – a manifestation of the sonic – always instantiates a concept of noise. As the last examples of historically specific techno-sonic and aelectro-sonic noises show, these concepts are a generative or productive means of approaching and shaping currently incommensurable or diffuse aspects of the world.

Techno-sonic noise as a sonic figure of thought filters and forms the contexts to which it is historically applied by highlighting the success or failure of communication processes as a computable quantity. Aelectro-sonic noise as its predecessor similarly directs attention to occurrences of electromagnetic events that transform the understanding of the earth in terms of more or less electrical territories, thereby also spurring an understanding of the planet as a global system of energy and communication. At the same time, it is also a qualitative inhibition of communication that stimulates further research in communication engineering, e.g. entailing an increased isolation of communication channels. In this sense, a sonic figure of thought evolves as a formative concept that derives its workings and meanings from acoustic or auditory phenomena but disengages from this original context to become effective as a generalisable means of thinking.

Investigating noise as an important component of sonic dispositives helps us to understand both the particular urgencies of dealing with sounds and the implicit strategies to meet them. The role of noise may be as different as its seemingly endless list of definitions implies, but its transformative effects can be narrowed down to a few strategies of countermeasures, affiliations, or circumventions that distinguish its application. Noise thinking, as a form of sonic thinking, is concerned with making sense of liminal phenomena where existing lines of thought and strategies of appropriation lead to difficulties or simply are not feasible. New experiences, such as those of aelectro-sonic noises, encouraged the will to reconfigure the frontiers between the known and unknown, the familiar and non-familiariseable, the appropriate and inappropriate, the included and excluded. Noise as a sonic concept delineates a thinking that apprehends such liminal phenomena, for instance, in the form of a surplus, a problem, or raw material. Such framings act as initiators of corresponding actions that range from silencing noise, e.g. in the urban context of audiometric noise measurements by the introduction of new laws and less noisy materials, to aesthetic appreciation in musical contexts, e.g. mimicking industrialised city noises by the famous *intonarumori* made by Italian futurist

Luigi Russolo; but also ranging from consequential epistemic work, e.g. by misusing telegraph networks as sensing devices for atmospheric electromagnetism, to methodological or conceptual transformations, e.g. modifying the system's parameters, as was the case when urban noise turned from unwanted sound into any loud sound, and from a behavioural to a communication issue. Once the diversity of noise phenomena can be navigated with greater scrutiny by deploying the notion of the […]-sonic, such […]-sonic noises themselves will help navigate research as they '[act] as an indispensible heuristic device in historical investigation' (Kahn 2013, 9).

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Navigating Noise at NEEM.

Dialogues Between Anthropology and Climate Science on the Spectres of Sound

Martin Skrydstrup &
Thomas Laepple

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Introduction

How do an anthropologist and a climate scientist navigate the soundscape of a deep ice-core drilling camp on the ice sheet of Greenland? In this piece, we are concerned with ice as a scientific object of knowledge, and we focus on the relationships between the disciplinary experiences of soundscapes in the camp and their abstraction into transduction vs. spectres of frequencies beyond human experience.

Nature has formed many types of ice formations. The ice sheet of Greenland was not formed in the same way as ice on a lake or ice cubes for cocktail consumption. It formed through hundreds of thousands of years of accumulated snow, which was pressed into glacial ice under its own weight. Such glacial ice is made of layers representing a snapshot of the snow that fell during a given season. Each layer of glacial ice contains bubbles trapped in the ice. These bubbles contain gases from the atmosphere as it was at the time the snow fell. This means that the Greenlandic and Antarctic ice sheets are forms of natural archives representing climate annals. Consequently, old ice allows us to track changes in temperature and precipitation across millennia. In order to obtain a climate record, climatologists drill deep holes in the ice sheets. Such ice cores allow us to travel back in time. The focus here will be on the retrieval of one particular ice core: the North Greenland Eemian Ice Core Drilling (NEEM, 2007-2012), in which both authors participated, along with some 100 other scientists, in the interior of the Greenlandic ice sheet over the course of five years. The NEEM record showed that the average temperature on Earth has fluctuated by as much as eight degrees over the past hundred thousand years. About 10,000 years ago, the climate entered into an unusually stable period, where average temperatures have varied by less than two degrees.

Ice cores drilled from the ice sheets have predominantly been understood by humans in *visual* registers, as physical properties of ice, and in *chemical* registers, as the chemical composition of the air bubbles and 'old snow' trapped and frozen in the ice core. Climatologists can then decipher the information inherent in these visual and chemical registers and translate it into written scientific texts. So far, ice core drilling and the scientific enterprise that retrieves these cores have not been the object of much scholarly inquiry into the soundscapes of ice. In this essay, an anthropologist and a climatologist ask what would happen if ice cores and the camp where they were obtained were switched from the domains of visual and chemical registers into the *sonic* field of perception. In other words, we ask what ice cores sound like and how they form an axis and acts of orientation for an anthropologist and a climate scientist at NEEM.

In this essay, we dwell at the same sites at the NEEM camp and articulate our disciplinary perspectives, paying particular attention to the sonic field. The stops along this itinerary take as their cue Tim Ingold's conceptual juxtaposition between *globe vs. sphere*. We argue that sound as an audible experience falls within the *spherical* mode of knowing the world as a sensory attunement, which is centrifugal and engaged, whereas sound as abstract frequencies resonates with the *global* mode of knowing nature as detached, centripetal, and as a cognitive reconstruction (Ingold 2008). We approach the NEEM camp from this dual perspective as a camp which, from the outside, presents itself as a *globe*, which is the detached objective view of science, and from the inside looks like a *sphere* (see images on the following page), i.e. a form of indigenous cosmology with dense social spaces and material practices. The *global* perspective is mediated by the instruments of science, vision in particular, whereas the *spherical* perspective is mediated by the human sensorium, hearing in particular.

→
NEEM from the outside as *globe*, copyright by Martin Skrydstrup.

→
NEEM from the inside as *sphere*, copyright by Martin Skrydstrup.

Anthropologist: Sound in anthropology

Listed on the staffing plan as an 'assistant cook', I was *de facto* an anthropologist working undercover at the NEEM camp. My hosts[1] had placed me in the kitchen, their thinking being that the kitchen was the main hub of NEEM, where an anthropologist would be able to pick up the heartbeat, the vibe, and the moods of camp life – in short, what my hosts referred to as 'camp culture'. Thus, the social life in the main dome as observed and participated in through the vantage point of the kitchen was what my hosts conceived of as my

1
The PI (principal investigator) for the NEEM project was the *Centre for Ice and Climate* (CIC) at the *Niels Bohr Institute* at the University of Copenhagen (UCPH), which invited me as a postdoctoral fellow in the Department of Anthropology (also at UCPH) and enlisted me as an assistant cook for the NEEM field campaign of 2010.

ethnographic object. This idea of camp culture was largely based on behaviourist ideas about 'culture', which, according to them, mattered in patterns of cooperation, camp morale, and work ethic, but not in the reading of signal/noise from the ice cores. Moreover, my hosts had to justify the actual camp roster vis-à-vis their funders, whose interests in the staffing plan did not necessarily include enlisting a camp anthropologist from the University of Copenhagen.

For five consecutive weeks, I performed my duties of assisting the main chef of the camp with the cooking of two hot meals per day for the 32-person crew of NEEM. I would often go to fetch seal, whale, salmon, or other meat for the chef in the deep freezer, which had been carved out as an extension to the sub-surface drilling trench. This allowed food storage in the ambient temperature of minus 18 Celsius. Running errands between the kitchen and the deep freezer enabled me to peek into the on-going activities in the drilling trench. In my self-defined role as an ethnographer of the hyper-technological with a focus on the material *circumstances* of knowledge production in climate science, the sub-surface trenches were the real heartbeat of the camp for me. Thus, after two weeks of full-time kitchen duties, I asked the field leader for permission to assist in the drilling trench. This request was accommodated with some hesitation. What business would an anthropologist studying 'camp culture' have in the drilling trench? However, in addition to assisting in the kitchen, I was assigned as an 'ice-core logger' in the drilling trench, where my task was to measure and number each piece of ice core that came up from the borehole – almost two miles deep – and log this into a computer. As I climbed down the steep ladder into the sub-surface drilling trench – literally immersing myself into the ice sheet – I felt a certain comfort knowing that I was probably the first anthropologist to join a scientific team drilling ice cores in Greenland.

My five weeks of fieldwork at NEEM adhered to the anthropological standards of 'participant observation', where an ethnographer participates in a foreign culture and at the same time observes it. From the vantage point of the kitchen, I

could listen in on conversations between researchers and observe camp life, while participating in the preparation and consumption of meals. From the drilling trench, I could observe science in the making and at the same time participate in the logging of the ice core. My more general task as an ethnographer of the hyper-technological domain of ice-core drilling and climate science was to describe how glaciologists arrive at scientific consensus, by way of a series of thick descriptions (ethnography) of the relations between researchers and their instruments, as well as the social milieu of the camp and its wider networks.

The ideal of 'participant observation' in anthropology is to achieve *immersion* with the object under study, which clearly gravitates towards the *participant* side of the participant-observation equation. Since Bronislaw Malinowski institutionalized the notion of fieldwork as the *sine qua non* for the anthropological discipline in the 1920s (Malinowski 1993, 1984 [1922]), this ideal of immersion has been articulated throughout the history of the discipline. The American anthropologist Alexander Goldenweiser, an early proponent of immersion, defined the ideal as 'an anthropologist must forget his own culture and immerse himself sympathetically (*Einfühlung*) into the primitive view-point' (Goldenweiser 1933, 349). A contemporary version of this ideal is represented by the Danish anthropologist Rane Willerslev's fieldwork among the Yukaghir hunters in Siberia, where his alliance with his ethnographic object brought him on a collision course with the Russian company exercising a monopoly on the national fur trade. With a warrant on his head for 'illegal poaching', the anthropologist was on the run in Siberia for six months, living with a small group of Yukaghirian hunters, where he was 'largely absorbed into the group' (Willerslev 2007, xiii). I quote Willerslev's rendering of this fieldwork experience at length, since it is exemplary of the disciplinary legacy of participant observation as a form of personal immersion:

'This enforced exile in the forest allowed me not only to *observe* matters such as the different phases of the hunting process and various practical and magical techniques for

dealing with prey and spirits, but also, through my *participation* in day-to-day routines, to become *personally immersed* in the hunters' mode of existence. Gradually, I started to experience their environment as they do: whenever I was out hunting, my every sinew would be straining to distinguish tracks and other signs of prey, and during my nightly dreams it occasionally happened that some spiritual being approached me with tokens of hunting luck' (Willerslev 2007, xiii, my italics).

In contrast to Willerslev's perpetuation of the classic anthropological ideal of immersion, the American anthropologist Stefan Helmreich is critical towards this form of ethnographic engagement (Helmreich 2009). In Helmreich's ethnography of marine biologists at sea in the Pacific, working and diving alongside scientists to discover microbes, he brackets ethnographic immersion as a form of unmediated presence and instead attends to the technical and epistemological circumstances that produce the experience of immersion. Helmreich asks what forms of nature, culture, and science are present and absent in immersions and 'what the metaphor of immersion – cultural, linguistic, technological - obscures?' (Helmreich 2009, 230). He expresses his critique in the following way:

'Immersion functions as a rhetorical tool promising experiential truth through eliding the question of structure – whether of an ecosystem or a social order – positing a fluid osmosis of environment by a participant-observer/auditor' (Helmreich 2009, 230).

What is of particular interest here is the ways in which Helmreich – as another anthropologist studying the hyper-technological in Euro-American culture – accounts for the soundscape he experiences aboard the submarine *Alvin* on its way to the ocean floor. Being in the interior of the sub *Alvin*, Helmreich writes rather elusively: 'Immersion equals intimacy, a feeling for the cyborg is accentuated by our subliminal and subjective sense of the sounds that surround us, sounds we are no longer encouraged to comprehend, let alone experience, as transduced' (Helmreich 2009, 222). Let us

leave Donna Harraway's complex notion of the cyborg for now and focus on Helmreich's new take on *transduction* to approach sound as a perceptive field in fieldwork. He defines the notion in the following way:

'I borrow the term *transduction* from the science of acoustics, where it refers to the conversion of sound signals from one medium to another – a borrowing I was inspired to by attending to how sounds from outside *Alvin* come to feel so present to those of us in the sub. I draw, too, on the more general, technical meaning of *transduction* as the transformation of energy from one kind to another, and I occasionally make use of its biological sense, referring to the relay of biological stimuli' (Helmreich 2009, 214).

Helmreich deploys the notion of transduction very generally, admitting that his use of the ethnographic present tense has 'its own potentially immersive effects' on his readers, where his 'ethnographic experience is transduced into ethnographic text' (Helmreich 2009, 223). Focusing on *transduction* is a mode of ethnographic inquiry which captures impedance and resistance in recursive systems and which can link instruments and people at a range of different scales, from the intimate to the public. Helmreich's claim is that the notion of *transduction* brings the interior and exterior, the anthropologist and his/her soundscape, and the sensorium and the sensed into an analytic of audibility. Following Helmreich, ethnographic immersion as a romantic symbiosis should be substituted with transduction as a mode to understand what the scientists are listening for both through and without their instruments and how they convert these sounds to other media.

Climatologist: Sound in climate science

Generally, in climate science we do not listen to sounds. However, we do understand and interpret our climate data within a spectral frequency domain as a sort of analogue to how a sound technician would work with a graphic equalizer. For us, there are not many clear frequencies (that is, 'clean tones') in the climate; in fact, I think I use the term 'noise'

about ten times a day in my lab. The only clear frequencies that appear in the climate system are the ones related to celestial mechanics. Examples include the daily rise and fall of temperatures from the rotation of the Earth, the annual cycle of cold winters and warm summers caused by the Earth's annual revolution around the Sun, or the cycles of 20,000 to 100,000 years created by regular changes in the tilt of the Earth, for example. The other variations in the climate system are noisier and thus spread out over many frequencies, as this is a typical property of complex coupled dynamical systems.

We follow these tones and analyse how they are modified or distorted in the climate system to learn and characterize the system. For the very 'deep' tones of several thousand years, for example, the cycle between ice ages and warm periods, we rely on natural archives such as the ice that recorded these past climate variations. As these archives are not perfect recorders but resemble more wobbly tape recorders, they also modify the tones in the archival process. In the case of ice cores, the climate signal is in the snowfall. However, snow does not fall every day and in similar volumes. Moreover, the wind blows the snow around on the surface, which creates dune hills and troughs, which again end up as 'noise structure' in the ice cores we drill. When air can still move between the pores in the snow, it mixes and mutes the climate signal. Finally, disturbances might also have happened to the ice far below the surface at the bedrock, where it very slowly flows and can create turbulence like structures and waves. Thus, a lot of effort goes into thinking about and analysing whether the 'noise' came from the climate transported by the snowfall or during its long stay and travel deep in the ice. Studying and simulating these natural tape recorders is my own particular sub-field of climate research.

Anthropologist: Sounds in the main dome

When the drillers at NEEM had made it past – or rather, below – the 2000m mark, this was a landmark achievement, which was celebrated by sprinkling champagne on brittle ice from ice cores. The soundscape in the glasses was not the

common one of ice cubes in a cocktail glass, but rather like tiny explosions, when the bubbles of gas trapped in the ice for millennia were released to the champagne with a high pitch. When the anthropologist put his ear to the glass, he could hear a glacial orchestra of cracking sounds he had never heard before. The glass was reverberant acoustic space – and the sound persisted after its initial introduction, albeit in different tunes. One could almost imagine how the cracking ice cubes transported the howling winds and low temperatures from that time in the past when the air bubbles had been trapped in the snow. I thought to myself that it did take a leap of imagination to think that the ice in my champagne glass equated with a time in the past, with deep implications for the future.

Climatologist: Sounds in the main dome

In the main dome, the sound reflected the collective and individual life of the camp. For me, the most exciting part of the science began when the main dome got calmer in the evening as dinner ended. The groups of people separated, and some left for a work shift in the science trench, to go to sleep, or to go upstairs where there were sofas and a kicker table. Together with a small group of scientists, I stayed on the lower level of the main dome and analysed the new data generated from the ice core during the day. The loud sound level of the dinner was replaced by calmness, creating a concentrated mood. Silent phases of typing on computers alternated with discussions about the new findings on what might have happened more than 100,000 years ago, when Greenland might have been warmer than today. In between, the soundscape was interrupted when the outside door opened as people from the science trench came in at the end of their work shift or to enjoy a break in the warm room. With the open door, the humming sound of the electricity generator standing outside entered the room. This was often followed up with discussions about the state of the drilling and how much new ice was recovered, telling one more chapter about the past.

Anthropologist: Sounds in the drilling trench

During my fieldwork in the drilling trench (see image below), I came to know Sigfús J. Johnsen (1940-2013), who pioneered deep ice-core drilling techniques (e.g. the *Istuk* drill) and wrote more than 200 publications, embodying the integration of *techne* and *scientia*, which is the ethos of Danish glaciology (Skrydstrup 2016). Sigfús was the ever-present 'drill-master' in the trench, constantly hovering over the drilling hole. However, consulting my field notes, I realize I never asked him directly about the soundscape of the drilling trench; neither did I ask him how he distinguished between signal and noise from the borehole. But I know that he would listen to the sound of the electrical engine powering the drill, which was full of noises, wanted and unwanted, some signalling risk, others success. If the engine sound became deeper, it meant that the drill had encountered resistance deep down in the hole. However, my field notes do not record how the drillers navigated the sounds from the borehole on a daily basis or how it informed their decision about which drill to use and when to add fluids, if at all. From my observations, I drew the conclusion that the sensory feeling in the manual controls and the data about temperature, impedance, and other parameters, which the drill cutters transmitted from the borehole to the control cabin, were of equal importance. Most significantly, the soundscape from the drilling hole was only accessible through technological devices that enabled hearing across long distances and across different media.

← The drilling trench, copyright by Martin Skrydstrup.

Bustling up and down the steel stairs to the drilling trench, either to fetch food for cooking or to log an ice core, I was on the lookout for an event in the drilling trench which went beyond the daily routines. This eventually happened with the arrival of the Swiss engineer Jakob Schwander. His visit to the camp was prompted by the drill approaching bedrock, which meant high risk, since the drill could get stuck and jeopardize the entire operation. To mitigate the risk scenario, the field leader decided to stop the drilling and deploy a seismic sonar logger called a 'pinger' in the camp, which was a prototype invented by Jakob Schwander.

A sonar logger transmits and captures sound. A steady metronome of 'pings' (giving the device its camp name) were dispatched from the device towards the bedrock. The pinger was an acoustic instrument consisting of two parts: a battery-driven electromagnetic hammer producing a sound signal of about 10 milliseconds' duration at a frequency of 5-10 KHz every 2nd second (the pinger), and a hydrophone receiving signals from the pinger. As sound travels differently in ice than in air, the question of response times forces us to consider the properties of ice. The speed of sound in ice varies with temperature, and the temperature varies with depth, so most of the time sound traveling through ice does not move in a straight line but bends like light through a prism. Moreover, sonar pings and pongs create an echoing sense. These factors imply that measuring the remaining distance from the drill to the bedrock 2,500 metres below the NEEM camp was no straightforward task, as many circumstances could influence the response time of the emitted signal.

The dataset produced by the pinger was given to a German climate modeler, Thomas Laepple, who understood the data set as 'quasi-measurements' which were 'inherently noisy' for the above-described reasons. For a climatologist, 'inherently noisy' meant that factors other than the distance to the bedrock influenced the sonic amplitude of the signal from the pinger. The German modeler (assisted by Sigfús, a Danish electrical engineer, and a Danish graduate student at CIC) was now tasked with filtering the 'inherently noisy' data from the 'real signal'. The axis of orientation that guided Thomas in this task was his attention to repeating patterns representing the real signal vs. stochastic signals, which represented random noise. Thus, the sight of graphic curves on a computer monitor guided him, rather than the soundscape from the borehole.

Based on this event, there are several arguments to be made about how the sonic registers of the NEEM camp serve as an axis of orientation. First, the machines do the listening, not the scientists. Second, the soundscape from the borehole in the categories of signal and noise are transduced into graphic curves on a computer monitor and, of course, from the analogue domain to the digital domain via the A/D converter. Thus, following Helmreich, we may argue that the work of the Swiss engineer in the drilling trench, as well as the work of the German climate modeler, could be understood as transduction. Both forms of transduction primarily serve the axis of internal navigation, that is, operational success within the camp.

Climatologist: Sounds in the drilling trench

During my time with the expedition, the sound of the drilling process was not audible, as it happened more than a thousand metres deep in the ice hole. However, the drill hung from a steel cable coiled on a large winch. The winch, driven by a large electric motor, moved the drill up and down. The sound of the winch while it rolled and unrolled the steel cable therefore defined the state of the ever-repeating drilling process. During unrolling, the winch slowed down and grew calmer as the drill approached the untouched ice several thousand metres below the surface. The sounds then switched to a faint hum reflecting the very slow downward movement during the drilling process. We hoped that this stage would last for a long time, as every minute meant several more centimetres of successfully drilled ice. As soon as the drill ceased to make any more progress, sometimes after several centimetres, the winch was reversed, accelerated, and started its long way up to the surface with a monotonous tone. The slowing down of

the winch signaled that the drill was approaching the surface. Now the soundscape and level of excitement rose as a team of people worked to dismantle the drill and release the ice piece from the drill tube. As time was of the essence, this team worked like a Formula 1 team servicing a car in the pit to make it ready for another race. This was accompanied by the slushing sound of the drill fluid and ice mixture pouring out of the drill. After the preparation of the drill, it entered the ice hole again, the winch sound accelerated, and the cycle repeated, again and again. This soundscape, with its dramas and intensities on the one hand and its mundane routines on the other, formed a rhythm that constituted the heartbeat of the entire NEEM project. The ice coming up from the borehole was not about sound, but the drilling did evoke a soundscape that defined the rationale of the entire operation.

Anthropologist: Sounds in the science trench

The soundscape of NEEM was not all alien pings and pongs. Located next door to the drilling trench, there was a much more familiar and ambient soundscape in the science trench (see image on facing page). Here, I encountered the tunes of techno and blues, indie rock and country; a soundscape that surprised any visitor entering the science trench. The interiors of the science trench had been carefully designed in Copenhagen. In close proximity to the drilling trench, a so-called 'core buffer' had been set up, where the ice cores were temporarily stored in order to be processed by the instruments following strict stratigraphic/chronological sequences. The instrumentation was designed around an assembly line organized according to the operational logics of destructive and non-destructive sampling of the ice core, as well as the particular questions that each of the nine scientific consortia posed to the ice. We might say that the architecture of the science trench was littered with particular questions for the ice core, and that those questions were increasingly aimed at the atomic components of the water and air bubbles trapped inside the ice. The ingenuity and sheer scale of the science trench produced an almost instant knowledge of the climatic profiles of the ice brought up from the borehole. Thus, the

architecture of the science trench turned the entrenched division between field sciences and lab sciences established in the literature of science and technology studies (STS) on its head.

← The science trench, copyright by Martin Skrydstrup.

In Copenhagen, before going to the NEEM camp, the director of CIC showed me video footage of the working patterns in the science trench. The footage showed the multiple steps of preparing the ice cores for knowledge extraction and subsequent packing. It was a clockwork of precision and demonstrated that each scientist assisted wherever there was a need. According to the director, the footage conveyed what she called the 'team spirit' of the science trench, i.e. the social organization of labor. However, the footage was mute. In fact, it amounted to a behaviorist idea about a shared common working ethos, cutting across the different cultures and consortia of the NEEM population.

When I first arrived at the science trench, the soundscape of mostly popular but occasionally classical music genres was the most immediately striking feature. At the beginning of each strictly regulated work shift[2] a scientist would plug his or her iPod into a loudspeaker system, which would make the tunes

2 First shift was 8:00-10:30; second shift was 11:00-13:00; third shift was from 14:00-16:00.

on the iPod reverberate throughout the science trench. This effectively meant that everyone had to listen in – there was no escape from the particular preference that was playing. There was an elaborate scheme for working out whose iPod would play during a particular shift. So, the authority to assert control over the soundscape to accompany the extraction of knowledge from the ice cores was distributed on an egalitarian basis. What is the function of this soundscape, and how is it relevant to the science conducted here?

When I asked certain scientists working in the science trench about the role of the music, they said it helped them to get through the daily routines in freezing conditions. The temperature in the science trench was maintained at minus 18 Celsius, which was just cold enough to preserve the integrity of the data stored in the ice cores. At one point during high summer, the temperature rose a few degrees in the science trench and air cooling measures were to be installed, but then the surface temperature dropped again, making this precaution unnecessary. The relatively short working shifts in the science trench reflected the rather monotonous and freezing working conditions. The answers I received about the tunes in the science trench somehow mirrored these harsh working conditions, as the scientists primarily perceived the music as a mode of coping. One scientist told me that the music from the iPod was 'the social and psychological means to normalize a deeply alien process of hard physical work in harsh and small working conditions in a quasi ice mine'[3]. Another scientist told me that it made 'the working conditions slightly more comfortable'[4]. A third scientist was a bit more frank, but also kept a certain ironic distance to the questions about sound from an anthropologist: 'The music keeps our sense of identity bathed in familiar melodies that shield us against the alien world outside … having background music for work is just cool … The music and our entrenched routines is what keep NEEM scientists from freaking out 15 metres beneath the surface of the ice sheet!'[5] These three answers gives us reason to revisit Mukerji's argument that 'by involving themselves in the use of their machinery, they [*scientists*] protect themselves from the assault of sense impressions at the sites'

3 Interview extract from my field notes from 2010.

4 Interview extract from my field notes from 2010.

5 Interview extract from my field notes from 2010.

(Mukerji 1989, 153). At NEEM, it could seem that the soundscape of the science trench is what protects the scientists from the icy environment, not the machines.

However, my own argument about the soundscape of the science trench goes beyond 'coping' and revolves around an interview with the field technician who knew every corner of the camp inside and out. He confided to me that the music you choose to put on in the science trench 'either makes you or breaks you!'[6] His testimony transposed the axis of orientation from 'coping' with the icy environment to the existential realm, where the preference of music was about identity and group acceptance. This axis of identity and existential navigation vis-à-vis the soundscape would also explain the fact that none of the scientists listened to their own individual music through ear buds. Doing so would violate the unwritten rule about performing your identity in the register of sound by way of submitting your iPod to a collective review of its contents. On the other hand, the form of teamwork and seamless coordination in the science trench would not be achievable if music prevented oral communication between the scientists. In other words, the nature of collective scientific work in the science trench required a shared soundscape, not individual sound bubbles. Based on my fieldwork experience in the science trench, I would argue that music is critical to the social construction of the work place, serving as a prerequisite to cope with the relative monotony in the science trench.

6 Interview extract from my field notes from 2010.

Climatologist: Sounds in the science trench

In addition to the music soundscape, the soundscape in the science trench was characterized by the sounds from the measurements, the preparation of the ice core, and by the ice itself. The first instrument in the science trench was the dielectric profiling (DEP) device that provided a first indication of the information hidden in the ice core. I was responsible for this device, which measures the dielectric properties of the ice cores by applying an electric field at 250khz (beyond hearing) and analyzing the current and phase shift in the signal. Thus,

the first instrument on the assembly line in the science trench gave an initial indication of the time-depth relationship of the ice core. The DEP device provided the first quantitative measurement after the visual inspection in the logger's trench. It was therefore of great interest, and there were often multiple people looking at the screen, predicting what we would see as we got deeper and deeper down towards bedrock, reaching ice no one had ever seen in Greenland. During this process, the sound provided feedback about the state of the ice, as well as the operational state of the DEP machine. The pieces of ice core coming from the core buffer had to be assembled like a puzzle, as every ice core ends with a break when it is pulled from the ice with the drill. The ear assisted the manual assembly process of turning the ice core pieces with thick gloves until they matched together, or made a crackling sound if small parts broke off and did not fit together. Thus, hearing was a critical aid in fitting the puzzle together and making sure the layers of the ice core were perfectly aligned.

I initialised the measurements by tapping on the keyboard. This started the stepper motors that drove a piece of a metal half tube sliding over the core to scan it. The motors created a rhythmic sound as the machine stopped every 5mm to perform a measurement and then continued. Here, the sound enabled me to control the process as well as the time. The measurement process took several minutes, which I used to help the next stations in the science trench, mostly the vertical sawing of the ice core and the horizontal sawing, the so-called 'Swiss saw'. Sometimes the DEP device got stuck because of some obstacle obstructing its movement. The high-pitched tone of the motors then signaled that I had to return to the DEP station, note the problem in the logbook, and restart the process. On the other hand, the sounds of the slide turning its direction was the signal that the measurements were all nearly done and the next piece of ice had to be inserted. Thus, the sounds emitted from the DEP machine served the purpose of operational continuity and efficiency. The sounds did not constitute part of my reading of the climate signal from the ice core. Instead, the DEP machine visualized the climate signal. During the movement and

measurements of the ice core, the results appeared directly on a screen in the form of a horizontal line that showed the conductivity of the core as vertical deviations from the zero line. Either signals, such as the imprint of past volcanoes or the change from a warm to a cold climate, or mechanical defects, such as cracks in the ice, were visible. This signal had to be separated from the noise by way of experience, by statistics, and by additional information such as re-measuring the core.

However, at one station in the science trench, sound was related to the reading of the climate signal. This was where the ice was prepared for an optical measurement by polishing its surface with a metal blade. Significantly, climate here translated into *visual* and *sound* signals, something that was unexpected, but which we learned from experience. Warm and cold ice has a different structure with different size ice crystals. At the ice crystal boundaries, the metal blade gets stuck for a very short moment while scratching, changing the scratching movement and sound depending on the past history of Earth's climate. Thus, we learned here that the climate signal can also be transported and read in the medium of sound. This came as a big surprise to all of us working in the science trench.

Inside the climate machine• Telling signal from noise

The current *zeitgeist* of the 'post-factual society' questions the ability of reality machines like NEEM to produce truth. Rather than doing this, we have explored the sonic axis of orientation at NEEM. Our concern is not to repeat the relativistic dogma that knowledge production is always sited and situated, but rather to shed light on the means of orientation in science through sound. We have explored the acts of orientation that enable scientists to read ice and (re-)establish their subjective positions within the soundscape of NEEM, which allow us to make two arguments, where the first concerns the disciplinary differences between anthropology and climatology and the second concerns how we should understand the relations between the human sensorium and the conduct of science.

First, what constitutes 'noise' for the climatologist is signal for the anthropologist, who subscribes to the idea that scientific discovery is more than the sum of its published data; the full account of science lies in the *noise* surrounding and leading up to the point of discovery. For the climatologist, the acts of orientation are geared towards filtering noise away to achieve the true signal. We hope to have shown that these two disciplinary perspectives – or axis of orientation – do not contradict each other. Rather, they are complementary and afford us a richer account of how science is made.

Second, our co-itinerary of NEEM has shown that sound does transport climate signals in surprising ways. This leads us to revisit Jonathan Sterne's critique of an alleged opposition and hierarchy of the senses: 'Hearing is concerned with interiors, vision is concerned with surfaces; hearing tends toward subjectivity, vision tends toward objectivity; hearing is a sense that immerses us in the world, vision is a sense that removes us from it' (Sterne 2003, 15). If we consider all the processes taking place in the main dome, the drilling trench, and the science trench as constitutive for reading the ice, then we would argue that the visual and the aural are mutually constitutive for knowledge production at NEEM. In this sense the human sensorium has to be understood as a dynamic whole, where seeing cannot be hierarchically separated from hearing. Our co-itinerary of NEEM clearly shows that sensory embedded epistemologies effectively cut across both biological and physiological differentiations between the senses in the conduct of science.

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Trying to Hear the Way.

A Neuroethological Perspective on Noise and Signal in Auditory Navigation

218.

Seth Horowitz

In a New England summer, an army of American bullfrogs surrounds a swamp, their overlapping low-pitched croaks interspersed with the plucked banjo string calls of green frogs and the occasional trill of gray tree frogs, creating a cacophony that spreads over kilometres and that few other land creatures could compete with or want to subject themselves to. Yet, a lone female bullfrog, hearing the chorus from a kilometre away, will hop unerringly towards it, the blurred but species-specific tones triggering an ancient instinctive phonotaxis. And once half submerged in the acoustic mayhem of her potential mating hotspot, her ears half in and half out of the water, her tiny yet fiercely focused brain uses the differences between the calls in air versus underwater to find a path to the loudest caller of her own species, confident that whoever can call that loudly and that long is probably the fittest mate she will find (Boatright-Horowitz et al. 1999).

Baleen whales migrate along hemisphere-spanning routes that have been stable for centuries. Female blue whales would listen for calls of potential mates and others of her species that could travel for thousands of kilometres, relying on the acoustic power of their low-frequency calls and the remarkable ability of underwater sound to propagate across entire oceans. But in the last century, the cacophony of human shipping, sonar, and explosive-based ocean floor mapping exercises, as well as the closely approaching prop noise of eco-tourism 'whale-watching' boats, has narrowed their acoustic active space from thousands to barely 100 kilometres or less (Hatch et al. 2011), driving them from their traditional mating and feeding grounds, and forcing them into unfamiliar and potentially dangerous new areas. The noise of oil platforms, container ships, cruise lines, and submarines arguably harms them as badly as whaling (Nowacek et al. 2007).

A cabbie in downtown New York City tries to figure out the best way to get to JFK airport after realizing there are brand new crosstown traffic limitations. Juggling the GPS input, avoiding pedestrians, vaguely noticing his favourite song coming on his stream conflicting with the sound from the always-on 'Taxi TV' monitor in the passenger compartment,

he sees that traffic is blocked solidly on all approaches to the Williamsburg Bridge. He pulls out his phone and tries to use voice commands to find a better route, when the passenger asks if there's any way he can turn off the damn monitor so he can make a call. The driver turns his head briefly to try to indicate where the 'mute' button was the last time he looked when a sudden blare makes him begin to turn around again just as the cab judders to the left as a small truck T-bones his vehicle. No one is badly hurt, but the officer who shows up looks suspiciously at the cell phone with the broken screen on the driver's seat while the driver protests that he wasn't texting, he was paying attention…

Navigation is one of the most basic and critical behaviours any organism uses to survive. Whether based on the simple neural network of a marine jellyfish or the complex specialized perceptual, attentional, and mnemonic systems central to the vertebrate brain, navigation requires extraordinarily complex concepts and behaviours that typically run without what humans would think of as conscious cognition. At its most basic, navigation can be thought of as orienting oneself as one moves through space towards a goal. This seems pretty simple. An ant leaves the colony and follows a pheromone trail to a food source. A honeybee orients on the phase of the sun and heads out in a direction where there are nectar-bearing flowers to bring back food for the hive, relying on a cognitive map formed in her tiny brain (Cartwright/Collet 1987). A salmon follows the changes in intensity and inclination of magnetic field lines to return to ancestral feeding and spawning grounds. And a human newly moved to New York City learns that the avenues run north-south, and streets run east-west, unless you need to head out to Brooklyn. Then you're on your own, as half the subway stops are closed for repair and buses have been rerouted due to construction.

In all of those scenarios, there are a few basic elements that hold true for everything from the female bullfrog trying to find a mate in the middle of a midnight chorus to the human desperately trying to figure out the modified G-line subway schedule change. At the heart of navigation is *orientation* – the

segregation of the self from the environment, the egocentric from the allocentric. The navigator determines its orientation by use of its senses, systems that transduce specific physics-based forms of the interactions between energy, matter, space, and time into the psychological representations of the inner and outer worlds that make up perception. Telesensory systems such as vision, hearing, and smell gather information about the environment separate from the navigator's body, whereas endosensory systems such as taste, touch, proprioception (awareness of the relative position and interactions between muscles and bones), and the vestibular system (which measures changes in the acceleration of the head) help to define the internal state (Murray et al. 2006). Integrating all of these systems into a cohesive whole is no minor feat.

While things happening in the physical world generate numerous simultaneous events, your brain is gathering information via sensory systems that often run at significantly different rates, ranges, and sensitivities. Standing near a tree falling in the woods is a visual, auditory, olfactory, and, if you're not careful, a tactile experience. And yet your visual system is running about 1/10th as fast as your auditory system, your sense of smell ten times slower than that (Horowitz 2012). Then, depending on which way the tree seems to be falling, based on vision, sound, and hopefully not touch, if you are reasonably attentive, you will fire up your motor system to move quickly away, relying on your proprioceptive and vestibular systems to monitor your acceleration and how hard you can safely strain your muscles on the uncertain footing of the forest floor and figure out the safest direction to move so as to avoid having the tree land on you. But if the exact same event occurred on a moonless night away from city lights, your telesensory perceptions would be completely different, with the first hint that you should move away probably coming via a tactile/proprioceptive rumble through your feet followed rapidly by the sounds of branches breaking louder and faster, until hopefully your endosensory systems would come online fast enough to let you dodge the invisible but just as dangerous incoming tree.

This is the simplest form of navigation: detecting a hazard and moving away from it. It requires little in the way of planning: the navigator responds to a potential threat by detection of a visually looming (and hence rapidly approaching) or acoustically startling (hence potentially dangerous and motivating) or other novel and unexpected stimulus, determining its position and direction of motion relative to the navigator and initiating a motor pattern that will allow the navigator to move away so that they can live to run away another day. It also highlights the most basic element of noise and navigation – the need for the navigator's perceptual system to be able to differentiate between signal and noise and apply that discrimination for their own survival.

There are several basic forms of navigation, all relying on the ability to identify and discriminate signal from noise, and each providing varying degrees of reliability and efficiency based on the resources the navigator can devote to them. The simplest form, *kinesis*, is similar to the example above, where you run from the falling tree to avoid injury. Kinesis is simply varying the speed and direction of one's movement based on a signal. This form of navigation does not require very much in the way of neural infrastructure, as shown by its use by single-celled organisms such as bacteria to navigate towards a chemical attractant. It is goal-seeking at its simplest, not even requiring memory to compare to previous actions. Another form of simple navigation is called *taxis*, which involves orienting the body towards some navigational cue. This can be as simple as a plant changing its growth hormone distribution so as to maximize its ability to gather light by turning its leaves towards the sun, or as complex as the aforementioned female bullfrog determining the position of the loudest calling male bullfrog at night by comparing the intensity and time of arrival of sounds at her two eardrums, and allowing her to swim in his direction.

Homing adds another level of complexity by integrating a return to the starting point, the basis of a 'round trip'. While the term 'homing' often makes us think of pigeons pressed into service to carry messages, it is in fact one of

the more common and yet highly complex forms of navigation. The homing organism, whether message-laden pigeon, nectar-seeking honeybee, or human shopper, needs both a destination and a known 'home' location to which to return. This requires significantly more complex neural and behavioural activities than orienting on a stimulus and moving towards or away from it. It requires that the animal have an internal sense of direction and movement, an external sensory system to correlate internal and external perceptions, and a method for determining distance and duration of travel. In short, their brains have structures analogous to a compass and an odometer, so that the directions and distances are represented internally as vectors that use 'dead reckoning' to create an internal integrated pathway of their travel. The problem is that simple dead reckoning is very prone to cumulative errors. Most organisms that carry out this type of complex navigation require more than sensory-motor interaction – they require the additional factor of memory – accessible storage of information that drives direction and distance of movement to not only reach a goal, but to store information about cues along the route that can provide waypoints to aid in reliable navigation. In short, in addition to a compass and an odometer, the complex navigator needs a map. And not just any map.

What makes homing more intrinsically complex is the need for inherent flexibility when dealing with environmental changes that can change the relevance, bias, or even accessibility of critical information. A honey bee flying out to find nectar using the polarity of sunlight as a navigation signal still has to be able to return home later in the day or if the sun is hidden behind some clouds. A human has to be able to get home even if there is a major traffic accident blocking their usual route. This leads to an expansion in the basic mechanisms of navigation. And as we know, the more complex a system becomes, the more prone it is to breaking down, unless you provide increasingly complex error-checking systems.

Imagine trying to find the address of a friend in a city you've never been to before, in a country where you don't read or

speak the language. A typical urban environment will have thousands of sensory phenomena bombarding the navigator every second: flashing traffic lights, car horns, near-infrasonic rumbles of a passing truck, the smell of diesel exhaust from a construction site, voices of street merchants and drivers, possibly exhorting you to come over, probably telling you to get the hell out of their way, street signs and billboards covered with unreadable text telling of unfamiliar products. To your friend who has grown up in this environment, it is full of signals to help guide them home, to shopping areas, to recreational facilities and schools. But to you in a novel environment, the signals are noise, adding to the distraction and making it even harder to try to figure out how to get where you are going. And while you haven't picked up a local cell phone card, luckily you printed out the annotated map your friend had emailed you, so you begin the task of navigating to their home. Someone watching you would just see you glance down at the paper, stare at it for a while, look around, turn in a specific direction and then walk that way, then look down, look up, reorient and walk some more, repeating until you hopefully walk up to a door that looks like the photograph on the printout and you ring the bell hopefully…

Noise is a perceptual concept, not a sensory one. As with the person going home in the town they've lived in all their lives vs. navigating a city you've never been in where you don't know the language, signals for one navigator become noise to another. So in order to understand how we can successfully navigate in noisy environments (that is, all of them), we should consider how the brain deals with signal, noise, and shifting from one to the other.

As mentioned, the brain is constantly bombarded with information from 6 to 18 different sensory modalities (depending on how you like to define your data streams). While each sensory information stream within a species is carried by similar neuronal populations, relatively constrained in their organization, kinetics, and pharmacology, it is still a daunting task to try to take visual, auditory, olfactory, gustatory, tactile, vestibular, and proprioceptive information, bring

them into a common spatial and temporal register, and then link them to executive systems to decide where to go, integrate memory systems to confirm where they've been, and check with arousal systems to monitor emotional responses to both events and goals. However, the vertebrate brain, in all its varied evolutionary and ecological adaptations, is rather spectacularly well adapted to the critical basis of these tasks by pattern matching.

The very basis of sensory perception, and indeed most neural function, is about bringing the naturally noisy pseudorandom firing patterns of unstimulated neurons into alignment. And once signals are aligned, they are no longer noise, but have become useful information, or signal. For example, your eyes lock onto and begin to track an object that is quite small. The relative positions of your two eyes, first in locking onto it, then converging as it seems to get larger, your visual cortex detecting multiple bands of alternating yellow and brown colour, rapidly moving transparent shapes above, a rounded shape with two larger, darker round shapes attached to it. These basic features are passed up the visual cortex, causing neurons to fire in a specific pattern. But while your brain is taking the quarter to half second to try to recognize the shape, a low-frequency buzzing sound reaches your ears, getting louder as the shape gets larger, and as there doesn't seem to be any fine difference in the time of arrival between your two ears, your auditory system, aligning with the oculomotor input from your two eyes, suddenly snaps the perception into an aligned audiovisuomotor pattern that indicates there is a single smallish buzzing object that is coming right towards you. As the signals leave your auditory brain stem, they begin overlapping with more visual pathways, split between the dorsal 'where' stream and the ventral 'what' stream, passing towards areas of increasingly complex albeit preconscious processing. Cortical neurons (which are primarily inhibitory, shutting off noise rather than adding more information) continue filtering the signals so that they fall into temporal alignment, increasing the coherence of the processed sensations to form a single perceptual object (Shamma/Michey 2010). And along the way, corollary branches seek

similar representations of signals from the temporal lobe, where memory is stored via the hippocampus, the input 'switching yard' where important short-term memories and inputs get shunted to form long-term memories or recalled to help understand or react to what's happening now. By the time you are consciously able to say 'bee', your brain has filtered, parsed, and aligned thousands of disparate bits of noise into a coherent signal, leading you to either think about flowers, honey, and the environment or run screaming like a little kid to avoid getting stung.

Noise can be thought of as 'information before meaning'. While we normally think of noise in the auditory sense, noise is in fact inherent in every sensory and information modality, waiting on a pattern-seeking system to be filtered, amplified, or modified to become (or interfere with) signals. However, any operational system, living or artificial, will have different parameters that separate signal from noise. This makes it much harder to define 'noise' and complicates the seemingly eternal quest to eliminate it. As a human living in the north-eastern USA, my home and immediate environs are relatively quiet as far as I am concerned, quiet enough that the occasional airplane flying over due to bad weather is distinctly annoying. When I take a trip to visit friends or colleagues in New York City, my opinion is reinforced, as the street noise just from basic human and vehicular traffic is a good 35 dB SPL higher than back home in Rhode Island. However, when I'm lucky enough to take a break and go someplace truly rural and removed, the kind of empty meadow surrounded by pine forest place people talk about when they say they are 'seeking silence', I realize that the quiet of home is actually relatively noisy. I realize I'm no longer hearing the faint hum of traffic from the highway a few miles away, not just that I'm ignoring it. There is no humming of the refrigerator motor or the clunking sound indicating that I really should defrost the freezer again. And if I take this isolation a step further, stepping into an anechoic chamber, where the floating floor and foam-covered walls and ceiling dampen everything but the sound of my own breathing, the isolation from noise is not comforting, but actually disturbing. True silence, an

actual lack of noise, is not normal or even possible in most environments, and it is considered alarming, even at a deep neural level (Paré/Collins 2000). The background noise that we ignore, whether low-frequency rumbles rising from busy roads like a city-wide low-fi speaker system, the common but ignored bodily sounds we all make, breathing, coughing, the tapping of our fingers against our phone screens, the susurration of fans or air conditioners, while classified by almost everyone who notices them as noise, are also subconscious definers and delimiters of our environment and our social milieu.

Acoustic navigation – moving through an environment by sound rather than vision – is often thought of as a special case. Humans are very visually biased, and in most cases vision will override sound as a preferred sense for moving about. If someone asks for directions, you are likely to tell them either to head in a specific direction for a certain amount of time, adding alterations to that vector as needed, or you will describe various visual landmarks along the way, with specific instructions on how to orient yourself in relationship to them. You are less likely to tell them to orient on sounds, unless it's a very specific and unchanging acoustic feature, such as 'listen for the rumbling of the waterfall. If you hear a splash, you've gone too far'. While we are remarkably good at localizing sounds in relatively quiet conditions (with most people with good hearing being able to identify the origin of a sound in the horizontal plane within a degree or so) (Mills 1958, Wood/Bizleya 2015), the transient and dynamic nature of most sounds, their sensitivity to masking and distortion by other environmental features, and, of course, the ubiquity of interfering anthropogenic sound can make acoustic landmarks unreliable.

And yet sound is one of the most common and successful modalities for moving about in non-human species, especially smaller animals whose normal hearing range is outside of most anthropogenic sources. The homing pigeon (*Columba livia domestica*), whose navigational abilities over long distances have been noted and used for millennia, is thought

to use magnetic sensitivity as its primary modality for orientation (Mora et al. 2004). However, observations of both event-based and seasonal shifts in the accuracy of their flights have led to the conclusion that they may be using infrasound (sound below 20 Hz) as broad-based navigational cues (Yodlowski et al. 1977, Kreithen/Quine 1979). The stable motion of air masses over large geological features and large storm fronts both generate infrasound, possibly providing broad-based location cues or interfering with navigation, respectively. Additional observations about a large number of homing pigeons becoming lost during a race after encountering the edges of infrasonic shock waves from a Concorde supersonic flight add an unusual but intriguing bit of evidence (Hagstrum et al. 2000). Pigeons using infrasound might seem to be a violation of the acoustic rule of thumb that infrasonic perception and utilization is typically in the domain of much larger animals, such as elephants and baleen whales. However, studies have confirmed that these relatively small birds have the ability to detect and respond to these low-frequency sounds, and some models suggest that they are using Doppler shifts to detect changes in infrasonic signals (Quine 1981).

On a less exotic note, while numerous recent studies have demonstrated clear anthropogenic noise impacts on bird populations (Slabbekorrn/Ripmeester 2008), recent studies have demonstrated that even relatively low-intensity, low-frequency road noise can contribute to habitat degradation. Studies using a 'phantom road', with speakers playing typical vehicular sounds along an otherwise quiet area, demonstrated that local bird populations actively avoided the area (McClure et al. 2013, Ware et al. 2015).

On the other end of the spectrum is the use of ultrasound (sounds above 20 kHz) by small mammals. While ultrasonic sounds are typically found in vocalizing animals with very small respiratory tracts, even in social communication (Arriaga et al. 2012), many of these species don't just listen passively to their environment, but rather emit high-frequency sounds and use the differences in time of arrival and spectrum of the echoes to model what is around them. Shrews, tenrecs, and

even rats have all been shown to use ultrasonic chirps and calls to monitor and move through their environment (Gould 1965, Riley et al. 1957, Siemers et al. 2009). Certain nocturnal cave-dwelling birds such as oilbirds (*Steatornis caripensis*) use relatively low-frequency (1.5-15 kHz) calls to generate crude echoes that let them avoid walls and other large features while exiting their home in darkness (Konishi/Knudsen 1979). But arguably the most successful acoustic navigators would be microchiropterans or microbats. With over 700 species in 19 orders, these creatures are found on every continent but Antarctica and are the second most common order of mammals on the planet just after rodents. Their calls range from constant-frequency hums that give cues about nearby foliage from simple echoes and identify prey insects by the Doppler-shifted echoes from their beating wings (Schnitzler/Denzinger 2011), to the broadband chirps of FM bats, typically sweeping from 100 kHz to 20 kHz and providing multiple levels of resolution of complex open environments (Dear et al. 1993), and also allowing them to use environmental acoustic 'landmarks' for orientation (Jensen et al. 2005). The calls are incredibly loud for those who can hear them, often at 120 dB SPL one metre from their mouths. If humans could hear these calls, a quiet summer night would sound like a war zone as dozens (or, in the case of Brazilian free-tailed bats, *Tadarida brasiliensis*, hundreds of thousands) of bats cruise through their habitat, seeking flying prey, avoiding foliage, and navigating to and from their home roosts.

Ultrasound is a useful channel for small animals, not only because it matches well to their small vocal tracts, but also because most environments are quiet in these frequency bands. Leaves and sticks rubbing up against each other and winds moving through certain spaces do make ultrasonic noise, but very high-frequency sound loses energy much more rapidly than lower sounds, with even a big brown bat's 120-dB call disappearing into thermal noise in 10-12 metres. But this limitation is in many ways at the heart of microbats' acoustic navigation abilities.

When, for example, a big brown bat leaves its roost, it scans

the immediate area with a series of loud ultrasonic 'chirps' – this allows it to confirm not only that it has a clear flight path, but also that there are no nearby aerial predators (such as crepuscular hawks, some owls, and even some other bats). After launching itself, when in large clear areas, it emits its scanning chirps only a few times per second. If it receives an echo, extraordinarily precise structures in the auditory brainstem and midbrain compare the signals arriving at its ears with the innate 'model' of its original echolocation signals and identify the range, location, relative movement, and some indication of the size of the object. Within a few milliseconds, it determines if this is a tree to be avoided, an insect to be chased, or another bat to be ignored or chased off, and it begins increasing the rate of its echolocation emissions. As it gets closer and closer to its target, it 'pings' it faster and faster, reaching a point where the signals form a click train, allowing the bat to switch from navigation and orienting to actually acoustically imaging and fine-targeting, emitting a 'terminal buzz' – a last-second fine tuning of position, where it stops echolocating and does a forward roll, slapping the bug into its mouth (as your mother told you not to echolocate and chew at the same time), then recovering and beginning the hunt anew (Simmons et al. 1979, Simmons 1989). The relatively rapid fall in the strength of ultrasonic calls and their echoes allows bats to generate multiple levels of auditory image resolution at extremely high speed, creating acoustical spatial maps similar to how we create visual maps based on optical convergence and flow from our two eyes. In short, bats use sound the way humans use vision – as a primary modality for finding their way in the world, with an arguably higher degree of spatial resolution and memory, as their movements are intrinsically three dimensional (Horowitz et al. 2004). However, before considering them as a model for sonic navigation being inherently superior, it is important to realize that they are just as prone to orientation error as any other living thing. This is borne out by a classic study (Griffin 1958, 1959, personal communication) in which a bat was trained to fly through a dark maze of chains in an anechoic laboratory flight room to receive a reward. To test its reaction time to novel stimuli along a well-known route, the researchers placed a wooden door in

the flight path to see how far away it would swoop to avoid the obstacle. The bat flew right into the door. (Nothing but its dignity was harmed.)

But even though most microbats tend to be solitary hunters, an insect-rich area near a body of water, a livestock yard, or even a streetlamp is going to be an attractive hunting spot. And like anyone who has tried to follow their friend's voice in a crowded bar can attest, finding your way around while everyone around you is yelling is difficult and frustrating. Bats are often another bat's worst source of noise (Corcoran/Conner 2014, Cvikel et al. 2014) and hence interference with navigation and hunting. And when you are a 15-gram animal flying at 60 kph in total darkness, pulling 9-G turns while hunting, using sound as your primary navigational and orientating system, any noise can mean the difference between a full belly and a successful breeding season or potential starvation. Bats will actively and automatically change the frequency range of their calls to avoid 'jamming' by other nearby bats (Hiryu et al. 2010). And when all else fails, like a neighbour who has had enough of the noisy party, sometimes they take matters into their own wingtips and chase off the noisemaking intruders, with pairs 'dogfighting' like WWI aircraft as they try to chase each other out of their hunting zone (Simmons et al. 2001).

But while biologists and ecologists will wax eloquent about our lifelong fascination with bats, frogs, and other auditory-centric organisms, most people are interested in the human context and experience. Can humans navigate by sound? And how does noise, either anthropogenic or natural, affect how we get around? As mentioned, for the most part, humans are visual navigators, with sound providing transient cues, such as car horns to alert you to approaching vehicular danger or hearing someone calling your name from across campus to invite you over for a drink. It's not that sound isn't an important environmental cue to us, but rather that vision is often overwhelming in its salience, and sound is so variable in our normal environment. Studies that examine human auditory psychophysics have shown that even untrained humans are

remarkably good at identifying the size and shape of rooms and spaces (Horowitz et al. 2005, Flanigin et al. 2017), and can even identify the shape or physical characteristics of objects using dolphin-like echolocation signals (Delong et al. 2007a, b). But studies looking at human abilities to navigate using sound alone are quite rare due to the difficulty of combining real-world motion with useful acoustic 'landmarks'. One study using a variant on the classic Morris water maze demonstrated that humans are quite capable of navigating based on sound alone through a large (25 x 17 m^2) controlled environment. By using artificial auditory 'landmarks' modulated with appropriate artificial head-related transforms, and relying on their patterns of movement as a calibration guide for distance travelled, subjects were able to locate even acoustically 'hidden' landmarks within the space by coordination of auditory-motor patterns (Viaud-Delmon/Warufsel 2014). However, while these studies confirm that humans have some ability to navigate by sound, they are occurring under highly controlled conditions, rather than the noisy ones of the real world. Our very sensitivity to auditory interference and the transience of acoustic features in most real-world environments are primary limiters for visually-biased humans. But there are exceptions to the typical human visual experience.

Watertown, Massachusetts, is home to the Perkins School for the Blind. Founded in 1829 in Boston as the first school for the blind in the USA, it moved to its current location in 1912. Entering the Howe Building, the main building on campus, is a remarkable experience for anyone interested in architecture, space, and acoustics. When you first walk in, there is what seems to be a normal school entranceway, with a relatively open waiting room, glassed-in receptionist area to the right, various soft chairs scattered about. As you proceed, you start to notice what seems to be somewhat eclectic interior design: wood panelling and linoleum in one corridor, ceramic tiles at the intersections, hardwood floors and walls in a music performance space, carpeting in another. The tapping of students' and teachers' canes becomes a normal acoustic element of the environment very rapidly. And if you stop and listen, as you move from one room to another, from one corridor to an

intersecting one, every space *sounds* different. Anyone with any interest in the acoustics of physical spaces could learn to navigate the space rapidly, just by walking around and listening to how footsteps, cane taps, conversations, and even air flow change in a predictable manner based solely on the materials and size of the specific space. This is true of almost any architectural space (and most natural ones as well), but it would seem particularly useful in an institution for the blind. However, this turns out not to be the case for a number of reasons.

Blind humans have been shown to position themselves based on auditory cues with significantly greater accuracy than normally or partially sighted individuals (Després et al. 2004, Voss et al. 2004, Doucet et al. 2005). Brain imaging studies have demonstrated that congenitally and early-blind individuals use areas of the brain dedicated to visual and other sensory systems for auditory processing and localization, thus potentially giving them greater plasticity and resources for navigation and orientation without access to visual information (Chan et al. 2012, Schinazi et al. 2016). However, detection and orientation in laboratory conditions are a far cry from moving about in real-world scenarios. Recent studies have begun questioning the supranormal distance estimation abilities of blind individuals when placing them in more realistic scenarios, pointing out that there is a tendency to overestimate the distance to far sources and underestimate it to near sources (Kolarik et al. 2017). Furthermore, few blind individuals are trained explicitly to navigate based on environmental audio cues, and even students in schools for the blind are taught to measure space by cane-length rather than acoustic or movement space (based on personal communication with J. Migliozzi). While there have been a few cases of 'expert echolocators', blind humans who use self-generated clicks to discriminate spaces and objects and navigate without other aids under limited circumstances (Thaler et al. 2011, Thaler/Goodale 2016), there is some question as to whether their ability to orient and navigate using sound is in fact due to using echoes to define space or some other mechanism (Wallmeier et al. 2013). Furthermore, the very uniqueness of

individuals claiming this ability shows both how rare it is and how subject it is to exaggeration in the media (Engber 2006). And although there has been a great deal of research into providing audio-based navigational aids to the blind, ranging from sonar-enabled distance measuring glasses to acoustically enabled canes and other objects that will notify a user when they are straying off a designated path (Loomis et al. 2001, Lewis et al. 2015), few of these systems are successful enough in the real world to become widely adopted, as all of them interfere with the person's innate sensory sensitivities, the signal for artificial navigation becoming noise.

So if auditory cues are of limited navigational value even to non-visual humans who rely on them, are they basically useless for typical humans in normal environments? The problem in answering that question lies in the applicability of the idea of 'typical' and 'normal'. For most of human existence, we lived as relatively small tribal populations of nomadic primates in what some might call the acoustic 'good old days'. We had several hundred thousand years to evolve when we weren't bombarded with phones calls, text messages, autostart web media, the bass from other people's music, street noise, loud bars, restaurants, and gyms – in short, the overwhelming storm of distracting, non-essential, and even just wrong sonic information that pervades daily life in the 21st century. Up to about 5,000 years ago, our sensory input was limited to what we picked up from the natural world, and we adjusted our behaviour accordingly, such as approaching the buzzing of a hive if we thought the honey vs. sting ratio was acceptable, or running away from the loud roaring thing no matter how fuzzy it was. And yet this palaeo-listening environment was still based on the transience of acoustic phenomena – the idea that sounds tell you 'something is happening' rather than the more fixed visual experience of 'something is there'. This inherent transience has likely always limited sound's ability to provide reliable acoustic landmarks to aid us in navigation until we evolved language and were able to provide helpful specific auditory cues such as 'I wouldn't go in there unless you're meaner than that cave bear (*Ursus spelaeusor*) or really bored'. But in the last several millennia, as humans reshaped our

environment to provide more convenient access to resources such as food, water, and each other, we began overwhelming these natural auditory signals and substituting our own. Rather than listening for prey moving in tall grass, we would approach the hawker making the most attractive claims for their prepared foods. Rather than finding water by listening for splashing on rocks, we hear a radio ad telling us to come to this store at this time for a special sale on bottled water. And rather than seeking a new home by listening to someone tell tales of better hunting and safer lands (laced with questionable accuracy in both direction and quality), we have GPS units or apps capable of giving us turn-by-turn directions to our destination across thousands of kilometres (although also of questionable accuracy if their owner fails to update them regularly).

But this hints at a potentially powerful role for audio in future navigation. While of limited utility for humans, whether 10,000 years ago or today, the ability of technology to pick up acoustic signals outside of the typical noise bands that affect biological hearing may help transform our transportation technologies. Robotic systems rely heavily on sonar systems for autonomous docking and orientation, particularly for underwater vehicles, in which the faster speed of sound allows for a longer detection and action range (Evans et al. 2003, Leonard/Bahr 2016). The current generation of 'self-driving cars' uses a combination of LIDAR, stereo optical cameras, GPS, and RADAR, but also ultrasonic sensors for rapid and accurate detection of suddenly appearing nearby objects such as pedestrians, and indeed the low computational requirements and rapid response possible with acoustically based SONAR systems is critical for collision avoidance in crowded and complex environments (Gelbal et al. 2016). And if we do somehow manage to move past the hype and land humans on Mars in this generation, explorers will for the first time have to cope with actually hearing the sounds of another planet (Petculescu 2016) and find a technological way to 'normalize' those sounds for human ears into potentially useful orientation or communication signals.

In summary, the roles of signal and noise in navigation are highly complex and often interleaved depending on the task, the environment, and the species involved. The beacon for one species is the blockade for another. Mechanisms for moving through the environment and their evolved compensatory systems for dealing with noise have evolved over the millions of years that animals have needed to move from one place to another. It is the emergence of anthropogenic effects on these environments, the human role as noisemaker across modalities and ecosystems, that evokes their greatest challenge. Yet, it is also the emergence of human technologies, which transport us with less effort in more complex environments than ever before, that provide a greater venue for sound and navigation, one of the most ancient neuroethological interactions on Earth.

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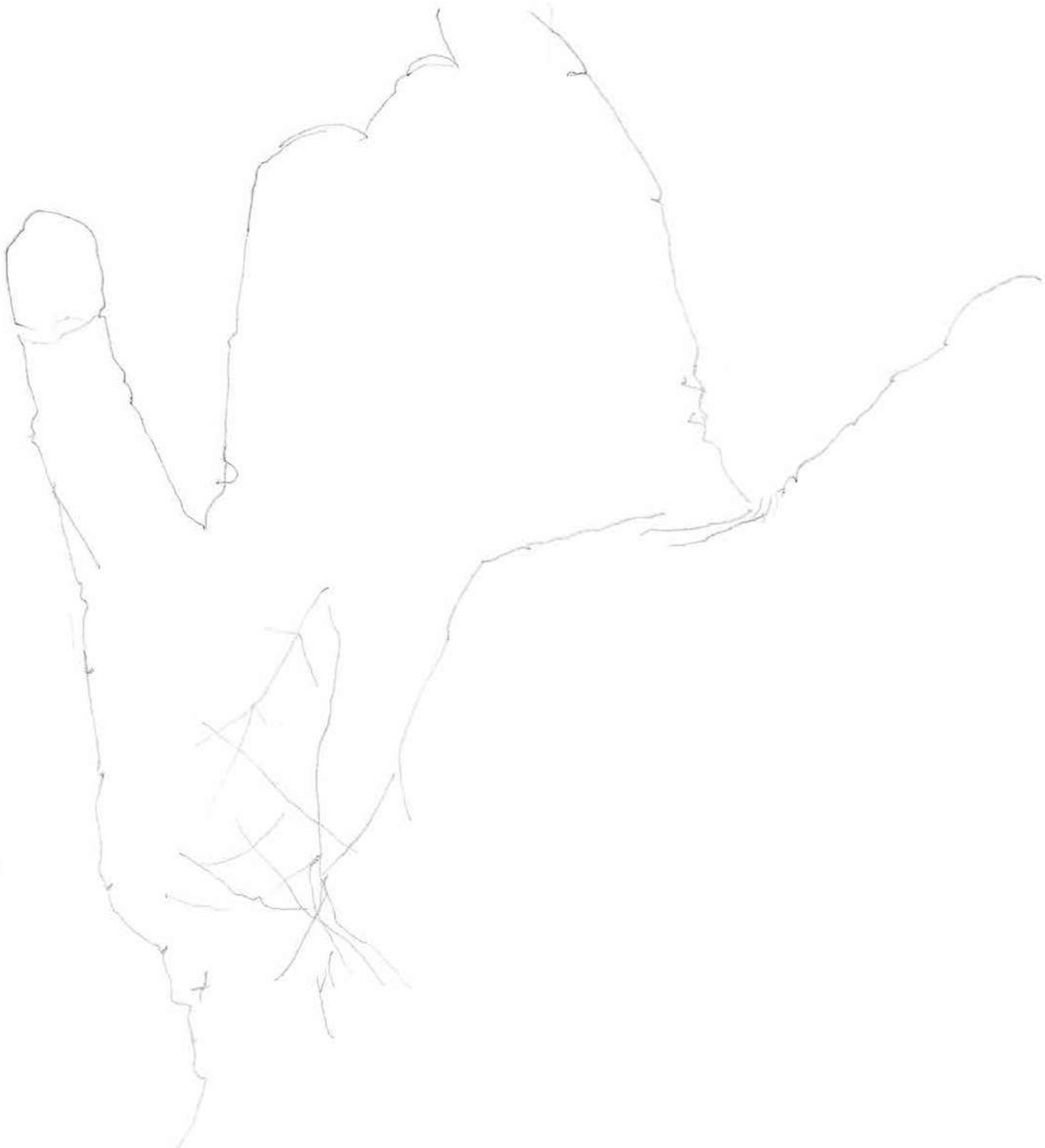


The Empty Signal.

Noisy Channels and Noise Music

Paul Hegarty

244.

'If there were only one possible message there would be no information, no transmission system would be required' (Shannon 1993, 173).

There is, then, a diminishing return in perfection, even in the quest for the best transmission of a signal, and for pioneering information theorist Claude Shannon. What would perfection mean? In technology, the quest for it just seems to lead to permanent, recurring failure. And does perfection even have any message? In fact, it sounds as if the perfect message is the failure of messaging – noise. So what if there were only noise, one message, a total interruption?

One model of noise is that of an interruption, disturbance. This is a view held by information/communication theorists, and society as a whole adjudges disturbance as noisy, as well as regarding noise as disturbance. Medically or biologically, noise is thought of as a threat. These models presume we know what noise is, and they provide only circular definitions. But the existence, development, and spread of noise in the context of music means we have another theorisation entirely, and that is to do with novelty, unfamiliarity, and judgements from conservative authorities, groups, and people that 'the new thing' is 'just noise'. Noise then contains judgements about what noise is. Noise also offers the prospect of permanent change, so writers such as Jacques Attali or Alex Ross, in a more limited way, regard noise as something that is seen as negative but represents progress, or a signal of progress. Once we can hear noise as potential, as avant-gardism, and possibly as something that occurs at a social level as well as within music, it is tempting to lose ideas of noise that are 'negative'.

But we have something called noise music, which is much more than noisiness or a new technique that some may find confusing. It is instead an attempt to keep noise noisy, to not let it settle and be a becalmed genre. Because so many people like the badge of noise, noise music has come to refer to itself as harsh noise. Alongside this, we have harsh noise wall. Harsh noise is about permanent variety and continual interference, whilst harsh noise wall, with which I will conclude,

is almost the opposite of that. Noise music can act as a critical method and be used to read other ideas about noise and music. Here I will be pursuing communications theory by considering the existence of noise music as a genre that does not want to be one, and harsh noise wall as a refusal of even noise music. Through these, I will examine how noise continues and infiltrates all that it is not. From the end as well as the beginning. But first, the beginning.

In the following I will try, through an examination of noise music and ideas of noise, to move beyond the current tendency to imagine Shannon's ideas as in any way definitive rather than historically situated. In so doing, these ideas (often as transmitted by Warren Weaver) become richer, more noisy, and more productive, suggesting in their accidents a way of understanding the reason why harsh noise music exists and what it can do as practice-based deconstruction.

Or

Maybe noise is basically about electricity – as source, product, consumer, producer – and is emerging into perception as a result of its technological mobilisation. Douglas Kahn has written of noise's intimate connection to electricity, from amplification (in *Noise Water Meat* (1999)) to the non-human generation of noises on Earth and beyond (*Earth Sound Earth Signal* (2013)). Noise slips out of our control, evading sense, escaping closure, and it is tempting to imagine it as being prior to human existence. Hillel Schwarz talks at length, in *Making Noise* (2011), of noise as a core component of origin stories, such as the noise of the Big Bang, still and always present as the cosmic background radiation and capable of being received across the space it defines, even on planets. This particular beginning helps us understand noise as residue, as something that can only be picked up later, in differed/deferred fashion, and that effectively only comes into being upon its being perceived/received (by ears, by humans). There is something more interesting, too, which is that while this sound might seem entropic, in fact it is the sign of the order that forms in its wake, and it, too, will be subject to entropy when the

universe reaches a point of expansion such that energy is no longer transmitted far enough to have any effect. There will be only noise and absence-of-noise at the moment where a sub-atomic particle sits isolated in its own nest, equally far from anything else and equally silent.[1]

1913 sends us echoes of another origin of noise, when the Futurist Luigi Russolo produced his manifesto, *The Art of Noises* (1986), which proclaimed that noise would be the basis of the future of all music, then of all art. Society would, in its turn, live inside an ever-increasing cacophony of industrial sound. Russolo's own noise-harnessing machines (the *intonarumori*) were promising, a sign of the renewal of the musical machine, even if they were mostly only used as ornamentation in fairly traditional orchestral settings. But he offers us two more ways of thinking about noise, which more or less contradict each other. He says that nature is full of noise, and that noise is life. At the same time, he proclaims his present and future to be the time of noise, because of the sounds of industry. In this second modelling, noise is an expression of the modern condition, even of the modern human condition. Anti-modernists might ruefully concur, and this will bear later fruit in the hands of R. Murray Schafer, as he moulds the reactionary idea of acoustic ecology.[2] But Russolo embraces the noise that drives us, the motion of the universe, like Lucretius or Heraclitus, or physicists such as James Clerk Maxwell and Ludwig Boltzmann.[3] Later on, I will be considering the latter as essential to the thinking of noise, as he moved from exploring entropy as disorder to thinking of it as the statistically natural (i.e. most likely, most common) state of all being. I will also argue that 'total noise' in music acts as an advance on this thought, one that stimulates an extension of the idea of noise away from communications theory and into a more cosmological state of being.

It is from the industrial discovery of noise that nature reacquires the noisiness it always had. And this results in the notion that music must expand, while our ideas of harmony, order, and silence need to be dismissed. This, of course, was a path not followed by Futurism as it fell swooning into the

1 Entropy is an idea that developed almost autonomously in both physics and communications theory. Both definitions of entropy imply a lack of order. For physics, entropy is the inevitable reduction in energy transmission that creates order, such that structure dissipates. The endpoint of that process is sometimes referred to as the 'heat death of the universe' and is strangely regular. In communications theory, entropy is the primordial chaos from which meaning, transmission, and order emerge.

2 The key reference point for the work of this researcher/practitioner of sound art and soundscapes is *The Soundscape: Our Sonic Environment and the Tuning of the World* (1994).

3 Heraclitus (c. BCE 535 – 475) and Lucretius (c. BCE 99 – 55) were unorthodox natural philosophers from Classical Antiquity, and both were interested in process, change, and speculating on the capacity for the universe to exceed human perception.

arms of Fascism… So maybe industry on a mass scale, in the ideal form of the factory, is the birth of noise. Certainly a good case can be made for the increase of noise in the narrow sense of 'volume of sound'. The same is true in the increase in ordinances against noise, and the idea that noise is something subject to legal control. Alain Corbin talks about bells in the French countryside that became noisy (were deemed noisy) after the Revolution and were melted down. Bells later re-emerge as tools of municipal control (*Village Bells* (1998)). So noise has something to do with social activity and machine use but perhaps pre-dates industrialised society as we understand it. Maybe the urban environment can itself be seen as a noise generator, with the mass of citizens, slaves, traders, and soldiers in ancient cities already creating a noise network/trace/filament across Africa and Asia. Noise in these cases can be a result of the unexpected as well as just the product of massification (i.e. a mass society is more statistically likely to produce new and unfamiliar behaviours *and* produce more locations, processes, and possibilities for them to happen), and Corbin's key point, as I see it, is that the low-density rural world that most people lived in until the 18th century (in fact, 'most' people have only lived in cities in the 21st century) and that is largely devoid of noise is quiet because life follows predictable, measured cycles, with hierarchies never shifting ground.

Noise, in this model of a predictable, bucolic, and largely rural life structured around the feudal system, would occur only in the form of huge disruptions such as war, invasion, or plague. There would still be privileged moments, argues Jacques Attali, like the village scene shown in Brueghel's *Fight Between Carnival and Lent* (1559) that is used for the cover of his 1977 book *Noise* (1985): the festival, and by festival we need to think of all major social events where the people featured, and extend the term to include witch trials, mass exorcisms, and executions. These moments of ritual, as paradigms of sanctioned transgression, represent the excess of actual sonic noise and the metaphorical risk of other threats to social harmony.

See Kahn (2008), and Lucretius *The Nature of the Universe* (1951), also translated [from *De Rerum Natura*] as 'The Nature of Things'. For Maxwell and Boltzmann, the two pioneering thinkers in quantum physics and proto-relativity in the late nineteenth century, see Maxwell, J.C. (1965), and Ludwig Boltzmann (1974). Of particular relevance here is the fundamental essay 'The Second Law of Thermodynamics', pp. 13–32.

What unites the above ideas is that noise is, or is the result of, some sort of concentration or condensation, including of the chances of the unexpected occurring, whether continually or momentarily. It is also something that organised, rational humanity seeks to either domesticate, punish, or ignore. This raises the question of whether noise can be an objective thing. I would say that it cannot, and any attempt to say otherwise is universalising a concept or phenomenon that varies according to the situation of the person identifying 'the' noise. Subjectively, what we all call noise varies; historically, it varies; historically or subjectively, it can flicker into and out of existence. Across cultures, what is noisy – what is disruptive, excessive, or wrong – varies dramatically. For Jacques Derrida, an origin (or source) is more of a justification than a fact. Look at the origin of humanity, or the world, or whatever you wish, and you will find an essential key to that thinker's subsequent theorising. What Derrida adds to this clear/obvious idea is that the notion of the origin is itself something like an ideological construct, a metaphysical presumption, and that, in fact, all we have are origins that we must have made at some late point and then placed back into time so that they could provide us with the idea of what the origin was. I find that noise is a classic location of this paradoxical attribution, with a common tendency to look on noise as an origin, or something that can be identified with an original moment or point. Far better to take Derrida's philosophy as a warning about the use of origins as ways of defining essences, and instead conceive of noise as being very much like Derrida's idea of *différance*, as something like an operator, or process, than a thing. For example, noise might be other to music, but the more interesting 'noise' is the way in which 'noise' and 'music' relate or seem to be having their relation undone by, say, a new piece of experimental music (i.e. the unfamiliar is not the location of noise but the vehicle for the possibility of thinking noise, thinking music).

'Noise' is a position on the noise being encountered rather than present in 'the' noisy thing that has made its way into the audition, no doubt unwelcome, uninvited, unexpected. Noise as something like the *un-*. Noise is how we find it

defined. So what interests me greatly is the prospect of something called noise music. Without noise music, a soundchild of the 1980s and 1990s, the idea of noise, the idea of finding a use for the idea of noise, would likely not have occurred, for all of Cage's earfiddling. This 'music' pushed the borders of genres, equipment, tones, notes, sounds into tangled messes of abstract noise collages, or exploded more monolithic practices through the inappropriate and excessive performance of norms. But 'noise music' – because it is a category that you point to, talk about, share, buy, sell, discuss, value – would seem to not be noise anymore. Just like Dada's anti-art, noise loses when it wins. At this point, writers on noise usually like to find examples of 'good' noise that do not fall into any traps and manage to salvage the 'true meaning' of noise. Not here, not yet, maybe never.

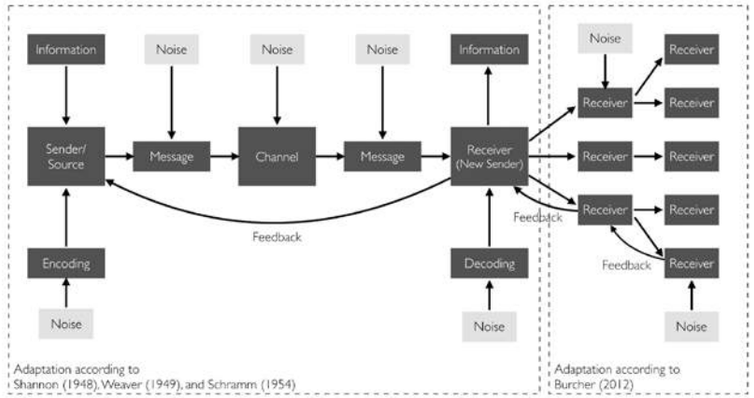
Instead I want to focus on the coding of noise, and all the example definitions I have mentioned feature in the coding and decoding of noise as a concept, and of specific musics or musical works and performances. The question of how we understand those things is a sort of coding in the widest sense, as is the social reading and subcultural use of it as an affirmative marker. I think that those types of coding will help tell us something about the process of coding and decoding in a narrow sense and how those can only be subject to permanent recoding once thought of from a 'noisy' perspective.

Not

Electric hums, static: enabling conditions for electrifying music and the creation of teleaudition. For Kahn, they are resources from the restless elements on the sound-friendly planet of Earth (*Earth Sound Earth Signal*), noise transformed into carriers of sound and, not much later, images. But the history, or industry, of the production, transmission, storing, buying, and selling of music has set its sights on a noise-free ideal sound. As each new technological leap made earlier generations sound noisy, inadequate, and properly de-valued, the dream seemed ever closer. Nietzsche, in *The Will to Power*, said that truth exists only as a construct, a sort of

wish-fulfilment, and is not out there, waiting to be discovered or attained. So similarly, audiovisual devices just cannot stop getting better. Apparently. From hi-fi, through the 1980s format wars in digital's first era as a mass commodity, to today's Blu-ray (today's Betamax?) and the endless precision-loading of remastered albums, perfection remains elusive. According to Jonathan Sterne, the widely held belief in a drive to perfection is just that, a belief, and that even in the context of the interest of consumer electronics companies to upgrade continually and resell marginally superior products, what we lived through at the end of the 20th century and in this one is the progressive simplification of media for music delivery – with the mp3 the paradigm, the apotheosis, the standard bearer (*MP3: The Meaning of a Format* (2012)). Sterne also identifies a possibly unexpected source for this lowering of fidelity, and that is the reduction of sound quality in telephony in order to maximise how many communications could travel along the same amount of cable. So, for Sterne, the heightened noise of the 'lossy' mp3 format is a product of post-war electrical engineering for communications.

Sterne is looking in the right place – Claude Shannon, with help from Warren Weaver, is the one who identifies the role of noise in any system or circuit. In Shannon's schema, noise is always there, lurking at the periphery of the communication circuit (or, more accurately, line), waiting to insert its input mid-message, mid-transmission, or mid-pulse. The system exists despite the noise, and its functioning is to be constantly worked on to reduce the effect of any noise insertion. Weaver attempts to universalise Shannon's system into a model for all communication, and so provides us with a new origin: the origin is the sender, establishing a connection with the receiver, and noise comes into being, like the snake in the Christians' garden of Eden, to disturb that complete connection. Where Weaver took the model, many recent writers have followed, as there is something timely about Shannon's *Mathematical Theory of Communication*, coming as it did as part of the development of digital binary modelling that would increasingly define most music delivery, as well as sound and visions of all sorts, and not long before John Cage's first



← Adaptation of Shannon-Weaver communication model (Mereu 2016).

presentation of *4'33"* in 1952, Pierre Schaeffer's development of the idea of musique concrète in theory and practice, the introduction of both 33 and 45 rpm records which established new meta-genres – the single and the album, and the fierce technological competition of the Cold War.

Shannon and Weaver's redefinition of communication as a sort of container that could be passed from one place to another helps create the sense of noise as a technical fault, a technical hitch, an extraneous interruption. A failure to be fixed. Sterne notes the convergence of the technical move to improve communications technologies and the development of new terrains of experimental music as part of a dualistic 'domestication of noise' (Sterne 2012, 94–95), and that both specifically include noise, only to dispose of its noisiness. For Cage, the noises of the world were now to be compositional resources for anyone in the world; for Shannon and Weaver, noise was a peculiarly integral part of the circuit, its incorporation dreaded yet always prepared for: noise as anticipation of noise. Weaver writes of the more or less organic generation of noise in any system, whether as a by-product or lurking external force:

'In the process of being transmitted, it is unfortunately characteristic that certain things are added to the signal which were not intended by the information source. These unwanted additions may be distortions of sound (in telephony, for example) or static (in radio), or distortions in shape or

shading of picture (television), or errors in transmission (telegraphy or facsimile), etc. All of these changes in the transmitted signal are called *noise* (Weaver 1969, 4–5).'

All of these phenomena occur in the delivery of electrified or improvised music. Reliability was 'rerouted' in several stages through the 20th century, not least through the purposeful use of feedback – a very different, overloading type of feedback, unlike the reinforcing strength of systemic feedback, but still a willed use of noise, an overcoming, or even domestication. Detuning, breaking, turning up too loud, playing wrongly – all these mirror Weaver's warnings about other communications noise and form a continuum of noise use in the circuit of avant-garde music or soundmaking. In short-circuiting the means of musicmaking, noisemakers also subverted musical expectations of the communication of music in comprehensible, reasonably predictable form. As experimental music introduces elements of noise across a range of practices, the readiness of the receiver becomes paramount – in fact, if the sound producer is looking for noise to infiltrate the circuit and be heard as such, the listener needs to be switched on yet specifically not ready for the rerouting of musical forms. The listener is not only a decoding device but has to occupy the position of transmitter – i.e. they have to be ready to re-encode the noise they encounter as music and effectively play it back to themselves as a recast message.

Although this process is fraught with the danger of becoming a faulty, 'noisy' receiver, as R. Haven Wiley notes in his explorations of animal communications in and through noise (*Noise Matters: The Evolution of Communication* (2015)), the set of required actions and responses sets up a new pleasure circuit and a new potential for noise, where decoding as a creative act involves the listener as producer, as hoped for by Cage with his many ways of musicalising the world in the listening (Cage was looking for a non-noisy, receptive listener). Pre-existing knowledge of the performance of known works or of the functioning of tonal systems, scales, and keys, the list of behaviours to be produced by audiences in different generic settings – this is supposed to be addressed, made

audible once noise enters the system of a specific concert.

Noise is not due to the thwarting of expectation because of the novelty of creative actions; instead, it consciously undermines the status of music, even the status of the performance in front of you, as machines, or even the whole concert, are opened to multi-facetted failure, in a subversive use of what Shannon identifies as a 'secrecy system [which] can be considered to be a communication system in which the noise is the arbitrariness introduced by the encoding process' (Shannon 1993, 179). This meta-coding is the machinery of noise music production, a known language to the fan, an initiation for the novice, a barrier to the sceptic. The production of extreme noise in the place of music can induce a panicked scrambling for the de-encryption machine. As Weaver notes with dread, 'if you overcrowd the capacity of the audience you force a general and inescapable error and confusion' (Weaver 1969, 27). Of course, it does not take long for listeners to adjust, to reset and move from one listening system to another, or they could of course leave, but it seems difficult for noise to not be reintegrated, leaving us with the still challenging but less noisy sense of music in an expanded field.[4] This field is not just the use of new practices, the shedding of older skills, the physical assault of ultraloud music, or enforced interactivity of a physical nature. It is also the spread of music into sound and, more curiously, into the state of intermedia. This is because, at the very least, the soundmaking is interacting with its own outside, its breakdown, and the audience becomes a medium in that construction. It should also not be surprising that noise can be visual, political, social, medical, …

4 This idea borrows the model established by Rosalind Krauss to talk of minimalist sculpture in 'Sculpture in the Expanded Field' (1979).

Is noise a construct of the analogue world? It seems that the rise of auto-destructive soundmaking goes hand in hand with the development of highly versatile and accessible digital musicmaking devices, programmed even to simulate problems such as glitching or the clicks and cracks of cosy old vinyl. All of the overdriving, distorting, damaging, retooling that we find in noise music comes first from analogue techniques and a time when analogue was developing hi-fi and advancing TV and video technology – Nam June Paik was misdirecting

TV and audio devices from the mid 1960s – in parallel with rapid advances in video technology. Japanese noise musicians often revert to the multiple possibilities of distortion that arise from analogue electrics and electronics, and they make a point of the importance of the technological reversion, a para-humanism of autonomous machines in place of emerging soft digital humanity. The digital seems to be a safe haven, where whatever tricks you would like to do can be reproduced and maintained at room temperature in CD/DAT/soundfile formats, a realisation of Shannon and Weaver's 'noiseless channel' (Weaver 1969, 17). Obviously, the digital came under attack in noise music from the beginning. Even earlier, electronic and computer sound devices were loved for their capacity to generate unexpected oscillatory sound excursions, and tape and computer held each other in a residue-generating bearhug. In short, an empty dialectic unites noisemaking and new technology, where each empties and lowers the other, instead of virtuously spiralling upward in mutual overcoming.

Weaver has more to tell us about the noise he wishes to overcome. Firstly, he seeks to clarify that noise is not the same as entropy – entropy is a feature of the message, the transmission – a sign of the level of possibilities to be contained. Noise, though, is an addition, leading to 'the received message contain[ing] certain distortions, certain errors, certain extraneous material'. Uncertainty increases, 'but if the uncertainty is increased, the information is increased, and this sounds as though the noise were beneficial!' (all Weaver 1969, 19). Noise thus becomes part of the information received and is part of an excessive transmission, so it needs 'subtract[ing]'. One way in which listeners do this is to understand noise as a message, to recode the entropic and supplemental information as the message – and the avant-garde listener's qualification as listener is coded via this skill (perhaps in line with Wiley's observation of bird-listeners' 'adaptive gullibility' (Wiley 2015, 167)). In an exact obverse mirror process to that of Shannon, Weaver, and also Norbert Wiener, the delivery/transmission/message becomes irrelevant – the circuit vanishes to be replaced by another, through which new content exchanges with the malleable receiver with

flexible, fast-coding listening.

The definition of entropy is somewhat contradictory in cybernetics – on the one hand it is clearly stated as part of the sea of possibilities that information could pick a point within, whilst on the other it is the direction of dissolution. Like the quantum particle, both seem hard not only to measure but to define. So in noise music, the surface of it seems to be entropic, massing information in a formless cloud. But actually, for all its apparent disorder, it is arguably just a more complex system (with many devices, i.e. overdriven analogue synths, or no-input circuits, purposely generating non-linear sound structures in a variegated, wobbling, or lurching whole). Entropic music or sound works can also be noise, but the noise occurs in the dissipation of sense: 'a steady degradation of energy until all tensions that might still perform work and all visible motions in the universe would have to cease' (Boltzmann 1974, 19). This could be the repetition of one note or musical move, the separation of incident, as in Morton Feldman, or a rampant non-sequential set of sounds, where logic is disguised, specifically attacked – as in constantly changing beat-based music, or microtonal or overtone music. In these cases, energy is dissipated through a reduction in communication between internal parts – at least as far as the listener is concerned. Any reduction of incident is entropic in the way physics sees it, while communications theory insists that even if entropy is indeed widespread, it is the material from which increased order arises – through increasing complexity and communication of energy.

Noise at its emptiest, or at its strongest as an emptying device, is a proper mobilisation of entropy, not just in the sound produced but in the removal of concentration, seriousness, or solidity of the listener's sense-making. At the extreme, such as Satie's *Vexations*, with its 840 repetitions of an atonal piano sequence, it acts as a condensation of time, transformed into the planing away of concentration and/or attention. Just such a possibility is present in white noise, or 'white thermal noise' as Shannon and Weaver call it. This multiple bandwidth/frequency noise is still a set range of sounds, and it is corralled

by Weaver into a controlled, factorable phenomenon. In music, or in noise, white noise would seem to be the ultimate expression of noise and entropy together, combining the two definitions in one solid mass of resistance. But we should also be aware that white noise, or noise of other colours, has been used for decades as a diagnostic device, a way of policing the accuracy of sine waves, currents, and, in general, signal delivery. It has also been widely used as a soothing device for humans, the multiple frequencies luring in attention only to slow it into restful inertia. In both cases, white noise acts as a sort of barrier, both seemingly infinitely mobile and static. Only the passage of a needle through the furrow of a record's surface or the obstinate movement of a CD player/digital device's clock shows us that normal time is still elapsing.

And

This still leaves us with Weaver's 'etc.'. On three occasions in his introduction to Shannon's theory he slips in this most unlikely word: 'the selected message may consist of written or spoken words, or of pictures, music, etc.' (Weaver 1969, 7), the list already quoted of noise-producing phenomena (ibid, 8), and thirdly, a list of things that could make up a message: 'letters, words, musical notes, spots of a certain size, etc.' (ibid, 12). You will note the inclusion of music – it is a regular indicator of the universal application of the idea of communication in Shannon, as Weaver reads it. But what is the 'etc.'? This strange surplus diminishes the clarity of explanation, so what does it do? It could be there to future-proof; it could be there as Weaver acknowledges the limits of his own knowledge; it could be there to indicate that content is irrelevant, or flexible, or open, or universal. But its apparent laziness suggests something much deeper – and that is the presence of noise exactly within the entropy of overall message potentials. Its peculiarity is not only in its openness, but in its display of the openness of the system – an awareness that noise is, if not exactly integral, then something more than extraneous. The presence of the 'etc.' is Weaver's attempt to bring the noise in, to contain it within the safer entropy of message potentials.

Noise is a threat to the transfer of encoded material, it eats away at the encoded thing in transit but never seems to affect the source – this is always a pure, intentional moment of sending (countered by Wiley's hyperbolisation of noise in communication circuits as applying to all phases and elements of communication (Wiley 2015, 135)). The sending brings sender and receiver into being, and they gather into existence as the message travels. The presence of the formless potential of 'etc.' tries to bring noise inside as a 'known unknown', and it illustrates that the 'whatever' of noise can be brought into the signal. But noise as the external input that *adds* itself as content and form still threatens the existence and nature of the terminals in communication – both encoding and decoding would reveal themselves as without foundation if noise can infiltrate the message fully. Noise music, as a music based on breakdown, the excessive pushing of machine and music, tries to do this – to unmake the connection between music and the understanding of music in a way that further eats away at meaning and understanding. Is this intended? If it isn't, why is it happening in place of music, where music should be? The place of noise in the cybernetic circuit is made less and less clear by the existence of noise music: it is inside and out, it helps define the other parts negatively (the bits which are not noise, but are in some way correct and in the right place).

Echoing the practice of noise music, Sterne says that noise travels along the communications circuit, even if still conceived as extraneous, parasitic. Mp3 is the culmination of the exploitation of noise in order to transmit more: 'rather than fighting noise, one could simply distribute noise in such a way that it would be inaudible in the presence of a signal' (Sterne 2012, 110). This happens through 'perceptual coding' (ibid, 2), which, in short, is a technique developed in the 1990s to exploit the noise in listening: i.e. not all of the sound of a high-fidelity music product is actually necessary, and some of the redundancy (or quality) could be removed with no loss of perceptual signal, thus increasing bandwidth on cables and vastly reducing the amount of bits of data that could usefully represent an audio track. But even this model presumes we

know what noise is at any point, whereas noise is broader or perhaps fuller than a technical specification. In addition, the universalising drive of the cybernetic model needs adjusting. For one thing, the technical circuit of sound delivery is doubled by a perceptual circuit. These circuits then flow into wider social and listening contexts and structures, receiving feedback and further noise from them.

→
Inside Bimbo Tower record store, copyright by Mary-Jane Lee.

Once again, the advent of a positively construed noise music will also introduce the possibility of noise moving location, and new circuits will have to be grown that allow noise to move not just as message ('here's some noise', transmitted and received knowingly at, say, a concert) but also as reconfiguring device. Experimental music has spawned, or fractured into, a myriad of microgenres, and each variant slides into a slot where its co-ordinates, its relative position, is known. The now defunct Paris record shop Bimbo Tower offered an alarming plethora of genres, extending to a dedicated 7-inch section for Australian and New Zealand noise. It had divided sound art into multiple variants, noise into subgenres, localities, labels, constellations; generations of performers found themselves touching fronds with newer hybrids… Such definition shows the twin impulse of the noise receiver: on the one hand to keep its noise, highlight its uniqueness, its contingency, and on the other to bring it into the realm of message, of containment. The rage to code noise knew no bounds in the shop, but they could never keep up. The 'etc.' was always there, spilling over, finding, filling, and exceeding

the ecology-building of the shop's human inhabitants. Japanese noise in Bimbo Tower had got so big it was allocated not only its own section, but its own domain, with individual artists who produce dozens if not hundreds of releases provided with their own niche. The thing called Japanese noise represented a multiple flowering of an excessive retranscription not just of noise but of genre. Within that growth, the height was the 1990s, and creeping through the entire landscape was and still is the anti-monument that is Masami Akita's Merzbow, with his 250 or so releases under that name. In so many ways the epitome of noise music, his peak moment as something new for East and West alike was the mid 1990s – and yet it seems impossible to fully say this music is no longer noise.

The sprawl, I think, is what keeps Merzbow noise, just as it does for later artists such as China's Torturing Nurse, who not only brings out vast quantities of releases, notably on cassette, but also moves indiscriminately between noise sub-genres, making the content of a release highly unpredictable. Even as listeners grapple with the sound mass, the endless churn of plastic and nanoscale file objects, they know they cannot conquer. Merzbow's insistence on the material is a continued resistance to the supposed dematerialisation of music, a maintenance of the object as itself a noisy thing. But the CD releases offer the highest possible level of noise in terms of volume and a sense of the multiple layers that feed a Merzbow piece. Albums such as *Hybrid Noisebloom* from 1997 still surprise with their onslaught. And it might no longer feel like noise for those hoarding their symbolic listening capital as they look for new listening to master, but until Merzbow (as the hypostasis of Japanese noise) reaches a mass public (one that never seems to arrive), it still has scope to suggest noise as being other to music. It still seems like an expression of the formless, a bringing to form that never coalesces, just as hi-fi can never reach its false ideal, or just as noise can never reach its apparent ideal.

Practically speaking, even if we allow Masami Akita his own genre, this stuff that he makes has a clearly defined place to

live inside the ecosystem of avant-garde soundmaking. It has a place in a history, however discontinuous, of noise. It's easy enough to find, and you can now listen to loads of it in degraded audio. Paradoxically, or not, Merzbow's distortions are at their best when allowed a reproductive format that can hold all the detail, that can make the message transmit. To the CD player, a Merzbow release is probably no more detailed than a 1970s prog album, maybe less so, despite what it sounds like to human ears. This is not quite the case when producing or recording tracks, when the editing and mastering is a constant battle with software, or when the record-pressing plant does not know which sound is supposed to be there, and whether the source master (usually a digital soundfile) is a correct rendering of material for pressing onto vinyl. This occurred to me when releasing *La Puissance de l'erreur* by Vomir, when the GZ Media vinyl press said on numerous occasions that their machines could not identify the track of harsh noise wall as a 'proper' track, or, if the mass of noise was the track, could it tell how to decide when the track should begin or end. But for the machine player, even when conceptually wrong, it is all information. Even in the live setting, anything other than complete machine failure is mostly information, or at least transmission.

The CD itself represented a way of playing with the digital, and much has been made, over time, of the potential of the glitch to revolutionise music, as it was the first type of sound to be produced from the failure of already-produced sound. As time went on, writers such as Caleb Kelly (2009) and Greg Hainge (2007) looked a bit closer and developed the idea that, far from challenging the digital, completed glitch projects rely on the apparent perfectedness of the format. Normally, a glitch comes from the laser misreading a CD, either as a result of mispressing, dirt, or disc rot (a surprisingly common fate for early CDs and many recent cheap CDRs). Artists such as Christian Marclay and Yasunao Tone used this effect to make sound art works from the late 1980s on, others such as John Oswald and Disc redirected pop energy into fractal ecstatics. Many decided to record glitches, or produce them digitally – creating a sense of a format under attack, but actually

troubling the listener through extended play. While the sound indicated 'stuck' or 'damaged' to a human, the laser continued reading – the glitch had been brought back into the circuit, and achieved its aesthetic effect through the combination of a sense of failing or noise while precisely depending on the reliability of playing and reproduction that digital formats offered. Glitch musicians therefore move the glitching from noise to information content, altering the habits of listeners and how they not only hear coding but how they are obliged to decode the music heard as properly coded.

It is no accident that these examples all derive from the 1990s, and despite the continued sprawl of both Japanese noise or music in the style of that noise, and also of glitching, we might wonder where noise is now. We might also wonder if it extends beyond the production of things as standard as records, CDs, soundfiles, concerts, installations, broadcasts, … This brings us back to a certain living-on, the surviving not just of noise, but also the paradigms laid out in the 1940s and early 1950s which established the places of messages and noise in seemingly definitive yet in fact utterly time- and context-bound ways. Beyond the optimistic universalising of the cyberneticists lies a way of maintaining their thought of noise as that which waits to intrude and which awaits controlling. Maybe there is some definitive way to keep noise going if we think that noise is in some ways always there. If that 'there' is not exactly 'here', if it is not inside or outside, if it is both behind, aside, and ahead of us.

Coding – at any level – from processing sound into formats to understanding a particular type of sound as noise and then making it a genre, is on an impossible quest, because its model of entropy is about possibility and extracting perfection from a sea of heterogeneous and infinite material. Noise as music, in trying to capture noise and re-present it, is also on a fruitless mission, and recognising this is at the core of the best noise practitioners (who know they fail to *achieve* noise). Maybe the way to conceive of this is to borrow Timothy Morton's idea of hyperobjects – something we can glimpse but that exceeds human comprehension whilst having a profound effect on the

world (Morton 2013). Then noise could partake of the wider cosmological, social, and historical meanings of noise, while only really being a tiny glimpse into all of that at any one time. This glimpse would also be a betrayal of the deeper *real* nihilism of noise. So instead of noise being an 'is', perhaps noise is a 'not' (like Blanchot's *pas*): not-this, not-that, not-quite, not-here, all the time proliferating as if it were true, as if it were a thing with a place, a being, a sense, that would be nearly something. Or at some point, not now, it would be. Maybe.

Maybe we can hear the last noise as it emerges only to fail. A few years ago, something called harsh noise wall tried to counter the pervasive colonisation of the term 'noise' by a host of post-rock, quirky performance, improv, and electronic activities. This time, noise would be not only full, it would be an emptying, an ending, a constant ending. Harsh noise wall, or HNW, is both the final tragic throw of the noise dice and also the undoing of the portent of noise as it congeals into absurdity. It consists of solid masses of throbbing noise, rich yet nauseating, comforting yet oppressive, its chunks of full-spectrum anomie are a resistance not just to meaning and music but to noise itself. Since the advent of harsh noise as music in the 1980s and 1990s, the debate between those wanting to make something that is still noise (i.e. a new avant-garde) centres around whether music should be layered with the noise or not… The circuit of music is totally reversed in this world, as noise becomes message that many would-be novelties in music wish to communicate. Avant-garde music continues, as does avant-gardism in many terrains, despite the cod-tragic destiny some attributed to art 30 years ago or so, condemning it to reference-rummaging, crate-sifting. Maybe the ubiquity of available sound consigns noise to a terminal periphery, leading the way into the entropy of everything everywhere all at once. Maybe formats can be subverted, manipulated, turned to good (sharing as redemption). Mp3 as noise? Return of cassettes as noise? Material culturists would like us to focus on consumption, on machines, on software. Instead, with harsh noise wall, the commodification of indistinguishable *packets* of noise is so absurd that it resists

appropriation for symbolic, moral, or commercial gain. It has now become contentless content, a parodic realisation of Shannon, Weaver, and Wiener's ideal cybernetic models, against the tragic situation of artists being 'content providers' whose work acts as a means of delivering a 'medium' (and by 'medium' what is meant is purchasable hardware, network connections, and patented software). Today's (human) wetware has never been more capitalist about music, and this reterritorialisation of listening into its devices not only matches corporate dreams and the activities of consumers, but is increasingly validated by the machine focus (material culture) of cultural studies of music or indeed of sound in society. Maybe noise in the 21st century, if it is to be disturbance, repudiation, excess, overload, lies elsewhere than where it nearly was for the last period. There is still plenty of dismantling to be done. That's where I'd go to look or listen. Noise is prospect and the dispersal of messianic hope in a dream of ever-diminishing value in noise.

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The Sonic Construction of the Ocean as the Navy's *Operating Environment*

Lino Camprubí

270.

In March 1958, the United States and Canadian navies held a joint symposium bringing together scientists, engineers, and fleet officers. The proceedings – declassified in 1971, and then only partially – featured a wealth of research programmes, devices, and theories aimed at turning the oceans into a space in which ship and submarine captains could orientate themselves and fight the Cold War. Its pages were filled with references to new sonar, relevant findings about sound propagation, and reflections on how to turn marine noises into meaningful signals. 'The Ocean as the Operating Environment for the Navy' was part of a longer history of efforts to acoustically navigate the opaque oceanic milieu (Office of Naval Research 1958).

For an environment to be *operating* is somewhat redundant. One of the first popularisers of the concept, the biologist and philosopher Jakob von Uexküll, precisely defined an environment as the milieu in which a given organism or species operated (Uexküll 1957). Rivers and oceans have served as perceptual and operating environments for all kinds of creatures since the Precambrian era. Orientation is perhaps the key operation. Mapping and locating food, shelter, or mates are among the most basic features of organisms with a nervous system, from early trilobites inhabiting shallow waters to the great mammals that migrated back into water after the Cretaceous extinction. The fact that, in 1958, navies were still working to make the ocean into their environment speaks only to the belatedness of human engagement with the deep. While surface and shores have allowed civilizations to flourish, grow, and destroy one another, the underwater world became human only in the 20th century.

Von Uexküll was perhaps better at theorizing animal worlds than at imagining how the *perceptive worlds* of different species can coexist, converge, and compete to form one single *operating world*. Turning seas into a military environment did not mean that the navies joined an already existing space as its new guests. Rather, it implied the creation of a new space.

That this creation was sonic meant that humans would soon be competing for frequency bands with other underwater creatures.

The very formulation of *the* ocean as a singular environment was a product of this spatial transformation. The completion of the process of unification of the oceanic space started with geographical exploration and globalization. The 20th-century's three-dimensional incorporation of the deep blue stressed the connections between hitherto distant oceans and seas by finding navigational routes, deep channels, and, perhaps most importantly, world currents circulating the globe by cyclical convection. While surface currents had been known for years, the existence of deep currents was a matter of intense controversy until the late 19th century. In the late 1860s, William Carpenter and C. Wyville Thomson mobilized some of Britain's best ships and surveyors to prove the existence of life in the deep seas. In the process, they also found that temperatures varied in the oceans much more than previously thought. They were quick to attribute these variations to moving water masses (Rozwadoski 2005, 153–162). But it was not until the physical oceanographers of the early 20th century developed methods to track water masses that notions of convection at a global scale became more than speculative theories. The oceanography of Albert Defant or George Dacon was no longer descriptive but mathematical and physical (Mills 2009, Hamblin 2014). Working with the currents that move across the world ocean entailed two layers of removal from experience: that of the sciences of the deep, and that of the sciences of the global.[1]

What I want to highlight here is that turning the world ocean into an operating environment requires pushing the limits of the very concept of environment. Anthropologist Tim Ingold and others have pointed to the contradiction between von Uexküll's environments *surrounding* particular organisms and the more recent notion of *the* global environment. While an organism's environment is given at the scale of its body and bodily operations, the global scale seems to go beyond the realm of individual perception and action (Ingold 2000,

1 For a development of this argument see the author's forthcoming article 'Experiencing Deep and Global Currents at a "Prototypical Strait", 1870s and 1980s' in: *Studies in the History and Philosophy of Science, Part A*.

Camprubí 2016). This is a rift that activists have perceived when advocating for protective measures against processes that populations and politicians do not experience directly (Eggleton 2013). Perhaps the key to solving the contradiction resides in the operational character of environments. Some authors have introduced the concept of 'environing' to capture this character (Sörlin/Warde 2009).

Operations at the global scale, then, are ways of producing global environments. Efforts such as those discussed in the 1958 symposium turned large chunks of the earth into operating spaces of orientation. They extended the collective mapping of reality provided by modern technologies and sciences. By navigating the three-dimensional oceanic space, Cold Warriors were doing more than discovering a pre-existing sonic reality. It was a process of active sonification, of tuning the ocean to new sound frequencies. I will return at the end to how this sonification allows us to reimagine the oceans before navies across the world turned them into a human environment. But first, looking at the oceanographic and political geography of sonification will reveal the transformative powers of mapping.

Noise and sound at sea

Many of those who have written about the sonification of the ocean, including myself, have expressed some degree of surprise at the title of Jacques Cousteau's book and documentary film *A Silent World* (Helmreich 2007, Camprubí/Hui forthcoming). By the time the book appeared in 1953, it was already well known that the oceans were filled with sounds. That sound travelled faster under water than above it had already been established in the early 19th century. By the end of that century, underwater microphones were turning mechanical waves at all frequencies into electrical signals and then into sound waves audible to the human ear ashore. Anti-submarine warfare from World War I onwards continually perfected technologies for transducing mechanical waves into signals. In particular, active sonar was invented shortly after the war, emitting pings that by bouncing off solid bodies

enabled sonar operators to calculate the distances of static objects and trajectories of moving objects. Acoustic sounding provided the means of both detecting submerged enemies and mapping the otherwise inaccessible ocean floor (Höhler 2003).

As a result of these listening practices, the old notion of the oceans as silent had faded by the end of War World II. Military-trained oceanographers such as Cousteau were all too familiar with the cacophony of sounds interfering with the acoustic targets of sonar operators. There was an urgent need to classify the many sounds populating the oceans and to train sonar operators to tell apart those produced by marine life and those generated by an enemy vessel. In one of the most rapid and massive efforts to produce new collective experiences, different navies embarked on a race for training new ears able to listen to new sonic objects (on the ontological import of collective observation, see Daston 2008). If Cousteau could still play on the old imagination as late as 1953, it was only because much of this knowledge was still classified.

Dolphins and whales are another unavoidable reference in this small body of literature. Here, ethnographers, sociologists, and historians follow a tradition set by practitioners themselves. It was in the context of sonar military research that the fact that some marine mammals use echolocation became apparent. Fishermen and divers were well aware that some species were rather noisy, but the systematic attention that marine biologists paid to the anatomical functioning and ecological function of these sounds came with military funding. Two recent books discuss the US Navy's Office of Naval Research as a context for the recognition of cetaceans as intensely sonic creatures. Historian Graham Burnett tells the story of how whales recuperated their mysterious and quasi-divine aura through works on bionics, weaponization, and acoustic classification (Burnett 2012). Joshua Horowitz, writing about a mass whale stranding in 2001, delves into the temporal and spatial interactions of biological and technological echolocation (Horowitz 2014). Both books reconstruct the competition for the ocean's sonic environment between the

two largest predators on earth – whales and humans.

Two aspects of such reconstructions are directly relevant to the argument developed in this paper. The first concerns the concepts of mapping and navigation. Military oceanographers, sonar designers, and biologists became interested in the echolocational abilities of cetaceans partly as possible models for navigating in the dark. Like their terrestrial peers, marine biologists routinely ascribe 'cognitive maps' to their research subjects. And, indeed, echolocation allows dolphins and whales both to detect prey and mates and to orientate themselves in months-long migrations across the world seas. The similarities to sonic sounding seem obvious, since sonar enables humans to both detect potential enemies and to produce increasingly detailed maps of the bottom of the oceans without the need to even set foot on them (Höhler 2002). However, as geographers have pointed out, representational cartographic maps are very different from cognitive ones. The distinction is again that of an environment as a milieu around a particular organism and *the* environment understood as a space to be described by a detached observer. The external geological and bathymetric maps of the ocean floor provide a view from above which is very different from the first-person perception of a milieu and crucial to the development of the ocean as a military operating environment (following two images illustrate the difference).

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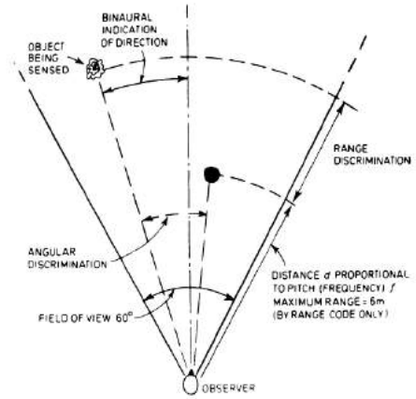
Illustration of multi-beam sonar system (reprinted with permission by NOAA 2017).



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Model of spatial observation (Kay 1980, 773).

But navigation and mapping do not fully overlap. While submariners and their hunters relied heavily on maps, moving through the ocean required them to descend from the vision from above into the kind of embedded vision from within that William Rankin has identified with the new territorialities that came into being with global politics and global positioning systems (Rankin 2016). The opacity of the oceans and the strategic demands of wars across the earth's oceans favoured global grids as points of reference in this new operating environment. This kind of navigation was combined with the careful sonic perception of those sounds available in the vessel's environment. Listening to potential enemies, sonar operators spoke of their ears as 'underwater eyes'.[2] Their perception was technologically and scientifically mediated and, as such, historical. Developing this collective experience required tools and training in the techniques to use them, but also new knowledge of water masses and their temperatures. The behaviour of underwater sound waves depends on temperature, and these studies of underwater sound propagation were particularly attentive to temperature layers between water masses (Hackmann 1984). The scientific relationships between circulation and convection emerged in research programmes linked to the urgencies of underwater listening (Camprubí/Robinson 2016). As described above, they are also a crucial part of turning the ocean into an environment of planetary scale.

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This language is still present in today's practice. See this recruitment advertisement by the Canadian Forces, for instance: https://www.youtube.com/?v=w7THIE2z97Y [Accessed April 25, 2017].

The second relevant point that can be derived from the

discussion of the oceans as environments shared between terrestrial and marine mammals continues with the theme of sound perception. The discovery that dolphins and whales are sonic creatures was more than a mere process of description; it was part of a process of turning noise into signal for the purposes of anti-submarine warfare and submerged navigation. As such, it was the result of the technologies for hearing, of the intensively militarized training of sonar operators during periods of war, and of the classification and identification of an ever-increasing wealth of sounds. This historical and technological dimension of the marine 'soundscape' has led some authors to refer to it as a *soundedscape* (Helmreich 2007, 625).

This leaves us with the question of whether the oceans were sonorous before or independently of the humans listening to them, to which I will return in the conclusion. The point now is that navigating the ocean environment was only possible through a semiotics of underwater sound. Ascribing meanings to hitherto unheard sounds turned the US and Russian navies into the main funders of marine ethology (Radick 2007). The process of turning noise into signal culminated in 1970 with the release of the album *Songs of the Humpback Whale*. Having worked as consultants for the US Navy, marine biologists Katy and Roger Payne grew interested in how other species used sound to orientate themselves in the oceans as well as to communicate with one another.

Conceptualizing as 'sounds' the mechanical waves transmitted at infra- or suprasonic frequencies involved an anthropomorphism similar to that of hearing 'music' in the whales' communicative acts. For world navies to turn the ocean into their operating environment, this kind of species reductionism was crucial. Once the technology to listen to the ocean was made available, ascribing meaning to the sounds being heard was a matter of identification, classification, and comparison. Targeted submarines, ships, prospecting explosions, and other artificial sound makers generated new sounds that could only stand out in reference to already known ones. Starting in the 1950s, the Narragansett Marine Laboratory, working

for the US Navy, developed a *Reference File of Biological Underwater Sounds* which continued growing through the years. It would allow sonar operators to compare new sounds to this catalogue to tell noise apart from target, and it thus worked in combination with techniques for acoustic monitoring, which I will discuss below. Global surveillance was embedded in networks of hydrophones, listening stations, and sonic databases that contributed to changing the geography of the oceans.

The geopolitics of sonic navigation

The current struggle to redefine the ocean's geography started shortly after World War II. From the early modern period, state sovereignty over the oceans emerged from a combination of two doctrines of Dutch origin: the cannon shot rule and freedom of the seas. The cannon shot rule defined state territoriality over its adjacent waters by the distance a cannonball could reach when shot from ashore – a distance averaged down to three nautical miles (Kent 1954). To the extent that the rule ratified already existing relationships of violent power, its operational definition is telling of the workings and limitations of international law: state sovereignty reaches as far as a state can defend its territory.

And yet, international law does more than that. It can itself become a tool for political power. In 1609, Hugo Grotius's pamphlet *Mare liberum* was published to justify the seizure of a Portuguese vessel not as an act of piracy but as prizing. This doctrine of the freedom of the seas entered into a game of competing powers. The Spanish and Portuguese empires had the Pope dividing the world in two through the global grid of meridians and without much regard for whether the imaginary lines of the Atlantic meridian and the Pacific antemeridian crossed land or water. The world ocean was closed into two halves; the Spaniards considered the Pacific to be an island sea, and the Portuguese exerted a monopoly over trade in the Indian Ocean (Parry 1990). Moreover, the two empires were dynastically united for almost a century starting in 1580. Against this background, Grotius's essay explicitly addressed

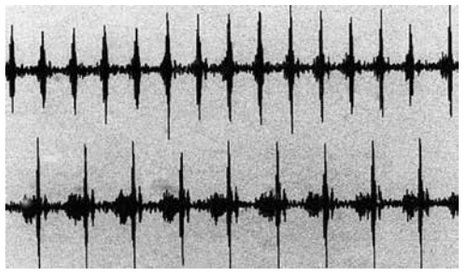
the Spaniards and 'appeal[ed] to those jurists among the Spanish themselves who are especially skilled both in divine and human law; we actually invoke the very laws of Spain itself' (Grotius 1916, 10). Grotius was quick to recall that the Spanish theologian and jurist Francisco de Victoria (1480-1546) had defended a doctrine similar to what the Netherlands were advocating for the Pacific: freedom of navigation as a means to ensure freedom of communication amongst peoples. Already in the mid-15th century, William Drake had defended Britain's right to cross all seas by 'encompassing' the earth in a voyage he closely modelled on the first circumnavigation, which had been completed by the Portuguese Ferdinand Magellan under the protection of the Spanish crown (Chaplin 2012, 35–70). A little less than three centuries later, when the British Empire had become the unquestionable world maritime power, the doctrine of the freedom of the seas served its imperial purpose of overseeing the world order across the seven seas. International law sanctioned already existing – and evolving – power relationships, but it also helped to reproduce them.

World War II marked the beginning of the end of the old empires and the rise of the US as the new world maritime power. As such, its Navy favoured freedom of the seas, the legal removal of any obstacle that would impede its warships in sustaining warfare on any point of the world ocean. But the interest of a state is seldom defined by just one of its pressure groups. The oil and fishing industries lobbied for Washington to join a number of countries which defended the extension of territorial waters to 12 and even 200 nautical miles. In 1945, the US declared that it would protect natural resources on its continental shelf, and in the next two decades most countries had proclaimed their sovereignty beyond the three-mile limit (Dyke 1993). The making of the new world order at sea combined the multiplication of nation states following decolonization with the global nature of capitalism and the Cold War. The United Nations hosted a series of Conferences on the Law of the Sea to unify criteria (UNCLOS I in 1958, UNCLOS II in 1960, and UNCLOS III from 1967 to 1982). In conjunction with its globalization, the world ocean became subject to hitherto unthinkable territorial compartmentalization.

Note that territorial waters were now applicable to the resources available thanks to the new technologies of offshore drilling and long-distance fishing. That is, territorial waters had acquired a vertical dimension hitherto deemed irrelevant. This three-dimensional aspect of the new laws regarding oceans put oil companies and fisheries in direct competition with the Navy's anti-submarine priorities. Around 1971, a classified document produced at the Institute of the Law of the Sea at the University of Rhode Island and shared with the Central Intelligence Agency explained what was at stake for the various US interest groups involved. The position of the Navy was very clearly defined: the United States should not sign any treaty that impeded its ability to move its fleets freely in order to launch nuclear missiles as a deterrence or to sustain local wars, as in Korea, Vietnam, or the Eastern Mediterranean. One of the cases in point was the Strait of Gibraltar: at only eight nautical miles wide, the three-mile limit ensured passage from the Atlantic into the Mediterranean, while the 12-mile limit would force US ships to obtain cumbersome permissions any time they wanted to cross. The 200-mile limit would effectively close the entire Mediterranean (Knaus 1971). The ocean space, which had been constitutive of the territorial division of modern Europe after the Peace of Westphalia in 1648, was also formative of the new international order (Steinberg 2001).

Once more, the reordering of the ocean space was tied to sound. After much negotiation, the United States was among the few countries that refused to sign the treaty. It did so because the final draft did not include a provision that considered 'strategic straits' to be exceptions to the three-mile rule. For a strait to be strategic means different things for the various players involved. For the US, it meant not only those straits to cross when launching an attack, but also those in which to mount detection barriers as part of anti-submarine defence. This detection was mainly sonic. Since the late 1950s, the US Navy had been deploying the Sound

Surveillance System (SOSUS), a worldwide surveillance system aimed at tracking Soviet submarines everywhere and at all times. It consisted of arrays of hydrophones passively recording marine sounds and sending them to stations in which electrical signals were automatically turned into graphic inscriptions of time, frequency, and intensity (see image below). Trained eyes would be able to 'see' the characteristic 'sound signatures' made by enemy submarines.



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Turning sound waves into images. In this case, the sounds SOSUS recorded were not produced by a sub but by a minke whale (Nishimura 1994).

The main focus for SOSUS and other detection systems was the deep sound channel and chokepoints (Weir 2006). For instance, submarines departing from Russian ports into the Atlantic would need to cross through the northern GIUK (Greenland-Iceland-UK) gap or through the Strait of Gibraltar. Both passages received unprecedented attention from engineers and oceanographers looking for the best methods of using sound for underwater surveillance. In the case of the Strait of Gibraltar, the gateway between the Atlantic Ocean and the Mediterranean Sea, there were preceding conflicts of sovereignty that changed in meaning in the context of anti-submarine warfare and North African decolonization (Camprubí/Robinson 2016).

To the general reader, the fact that ocean geographies change as a function of surveillance is perhaps more obvious today than it was during the Cold War. As refugees from Middle Eastern wars, African scarcity, and a changing climate try to enter European countries, the latter are endeavouring to build a new southern frontier. This border would allow for the dissolution of the old national ones while reinforcing a

common barrier made of satellites, rescue ships, and barbed wire. Agencies such as Frontex and Eurosur have inherited the military notion of the ocean as an operating environment. While they navigate the Mediterranean via GPS and use satellites for detection, sonic barriers still play an important role in the retooling of the Mediterranean geography. NATO has deployed at least two submarines and a number of sonobuoys (floating buoys equipped with expendable sonar which send acoustic data to monitoring stations) to help track unidentified vessels carrying drugs, weapons, or undocumented migrants. The construction and maintenance of the ocean space as a surface for capitalist circulation mobilizes not only violence but also legal and political concepts such as piracy and security (Glück 2015).

As John Hannigan has recently argued, different groups are active in pushing diverging projects for this social and material construction of the ocean space (Hannigan 2016). This was quite explicit in the 1958 Canadian and US navies' attempt to turn the seas into an operating environment. In this paper, I argue that oceanic security involves the sonic retooling of the ocean. But we must not forget that turning the ocean into an operating environment also has transformative effects on bodies and geographies ashore (Kovras/Robins 2016). Our digital age of virtual transactions and communications depends on a dense network of underwater cables, the protection of which raises increasing concerns and produces special kinds of landscapes around stations and points of landing (Starosielski 2015).

Underwater cables are important not only to the defender, but also to the attacker. During the Cold War, the US Navy deployed submarines to hamper and spy on Soviet undersea wires (Sontag/Drew 1998). The oceanic environments that navies across the world step into are increasingly artificial. The merging of man-made and natural sounds that constitutes the core of this paper is particularly helpful in understanding what is at stake in producing an operational environment.

For submariners and submarine seekers, making themselves at home in the ocean meant turning it into a soundscape (a soundedscape). On a very basic level, this meant adding new noises to the long list that humans were already responsible for, such as engines, dynamite explosions, and drilling. But it also meant reimagining the oceans from *silent worlds* into spaces so noisy that sound archives and catalogues became crucial for navigating them. To a certain extent, we could be reassured to think that oceans were always sonorous, even before marine life populated them, by way of volcanoes, cracking ice, or atmospheric storms. And yet, it is worthwhile to pursue the conundrum this implies: as physicists and neurologists know well, when we call certain mechanical waves 'sound', we are making reference to a perceiving subject with sensory organs and a nervous system (Schnupp/King 2011). To what extent can we then say that the ocean was actually sonorous before we put into place the transducing technologies that allow us to hear to it?

This is one of the classic problems in philosophy, exemplified by the sonic example of the tree falling in a forest with no one there to hear it. It led bright minds to extreme forms of idealism, as with Archbishop George Berkeley and his definition of being as being perceived.[3] Most reduced the problem to the status of the existence of what Galileo Galilei and subsequent natural philosophers called secondary qualities – entities which, like sound, require perceiving subjects. An example from the sonification of the ocean may reveal the relevance of this issue to the present discussion. When Maurice Ewing and Stanley Wong discovered the 'deep sound channel' in the midst of World War II, they showed that it transmitted mostly low-frequency sounds, some of them in the infrasonic range. This fact would soon be deployed by the US Navy to 'hear' submarines sailing thousands of miles away. But calling a pressure wave 'infrasonic' or 'suprasonic' is decidedly anthropocentric: first, it uses our hearing scale as the threshold, and then it extends the sonic realm far beyond our actual sonic experience.

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A good summary of the controversy can be found at *Stanford Encyclopaedia of Philosophy*, entry 'George Berkeley', subjective idealism: https://plato.stanford.edu/entries/berkeley/ [Accessed April 25, 2017].

It is thus not surprising that those of us interested in the social construction of the ocean and its sonification are tempted by the idealist notion of taking our imagined version of the ocean to be the ocean itself. The alternative conception of naïve realism would require us to suppress the active engagement of humans in making the ocean sonorous. I want to argue that this is a false dilemma. On the one hand, the technological transformation of infrasounds and suprasounds into audible frequencies justifies this extension of the sonic realm, since it is made possible through actual continuities of energy flows and signal. On the other hand, and of central interest for this paper, animal perception provides what philosopher Gustavo Bueno called 'the zoological argument against idealism' (Bueno 1992, 344–346 & 864–868, Bueno 2013). The acknowledgment by navy scientists and ethologists that cetaceans use sound to navigate the sea, and that they do so at various frequency ranges depending on the species, forces us to reformulate the old dichotomy between subject and object. The S/O scheme shared by idealists, empiricists, and phenomenologist philosophers can now be replaced by a materialist view that understands perception as a process of filtering at different scales by different kinds of animals.

The transducing technologies turning mechanical waves into waves audible to us adapted the oceanic reality to the perceptive filters of the human nervous system. But the fact that whales and dolphins also perceive pressure waves through an ear system very similar to that of terrestrial mammals allow us to affirm that oceans were sonic long before we filled them with sonic technologies. We are back to von Uexküll: 'the same contrast [that between physicists investigating light waves and physiologists interested in colour] exists between the *Umwelten* of a student of air waves and a musician. In the one there are only waves, in the other only sounds. Yet both are equally real' (Uexküll 1957, 80).

Beyond Uexküll, again, the main issue at stake is how the different animal *worlds* interact, how they actually refer to a single world filtered at different scales. The tragedy of noise pollution makes this all too clear. Constructing the ocean as

an *operating environment* required technological engagement with an already sonified realm. Its human sonification has put military sonar into competition with echolocating animals that are disoriented or scared away by its pings (Schaar et al. 2011). While humans have turned cetacean noises into signals useful for navigation, our signals are, for them, the most deadly noises.

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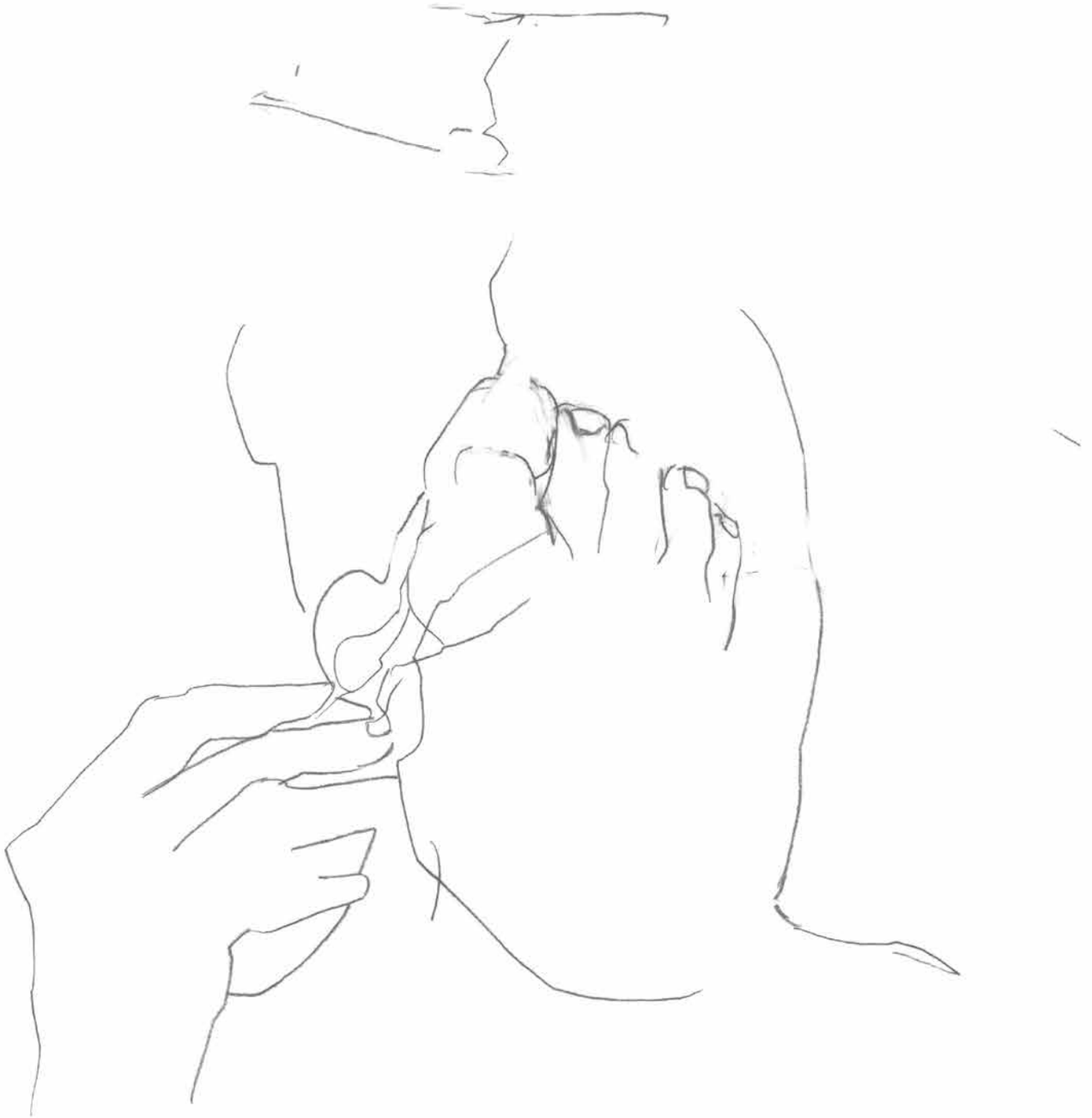

Kerstin Ergenzinger, *Mentalscape*.

AFRICAN NOISE FOUNDATION: We promise nothing, we bring the noise. Recent works include *Through the ear, we shall enter the invisibility of things* (6 min. 23 sec., HDV), directed by Nicola Deane, a co-production with the Visual Arts Department, Stellenbosch University. World premiere at the Oberhausen International Short Film Festival.

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Kerstin Ergenzinger, *Acts of Orientation, Wanderer Prints*.

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Colophon

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