

WHAT IS SOUND?

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ABSTRACT

What is sound? This question is posed in contradiction to the every-day understanding that sound is a phenomenon apart from us, to be heard, made, shaped and organised. Thinking through the history of computer music, and considering the current configuration of digital communications, sound is reconfigured as a type of network. This network is envisaged as non-hierarchical, in keeping with currents of thought that refuse to prioritise the human in the world. The relationship of sound to music proposes ways of thinking about and tapping into the network, in the hope of re-enchanting sound with the grace of art.

1. INTRODUCTION

1.1 Computer Music

It is exactly forty years since the first International Computer Music Conference was held, at Michigan State University in East Lansing, under the chairmanship of David Wessel. At that point, in 1976, several strands of thought, creative practice and technology had come together to inform a research agenda that coined the term, computer music; and that term has been with us ever since.

Even by 1976 I suggest that the term covered a pretty broad range of technical and aesthetic concerns: alongside Max Matthews' MUSIC programs, Iannis Xenakis was developing his UPIC system in Paris, Peter Zinovieff in Putney was using a minicomputer to control his Synthi voltage-controlled analogue systems, in Utrecht, Gottfried Michael Koenig was developing algorithmic and synthesis software in his series of Projects, and so on.

The point here is not so much to tell the history of a widely distributed effort, involving many extraordinary individuals, as to recall for a moment the nature of the enterprise, and in particular the contrast between excitement and effort. A computer in 1976 was the size of a large refrigerator: it cost many thousands of dollars, and required space, an air-conditioning system, and dedicated administration. Computers were exciting because they represented power and potential. They were associated with the space-launch programmes, and in their science fiction representations they assumed the intelligence of human beings. Indeed Artificial Intelligence was a re-

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search area boasting university institutes and a frisson of highly public anticipation.

The cost of computers, and the knowledge required to look after them meant that they were out of reach - and thus outside of the knowledge - of ordinary people. They were exotic and quixotic, and they held the prestige of being at the very frontier of technical, scientific and industrial advance. To make music with computers was to assert the power of music as an art. On the other hand, their actual operation was difficult and time-consuming. Even typing commands into a dumb terminal was often a non-real-time activity. Programs had to be written, debugged, compiled and then run sometimes for many hours before a result was forthcoming. I remember myself, at MIT in the early 1980s, taking twenty-six hours to compute a modest five minutes of sound, and that then turned out to contain some unwanted distortion and had to be computed again.

The point of this brief moment of nostalgia, is not to wonder at the advances that have taken place subsequently, but to take stock of the methodology at work here. To work with computers brought prestige, and demanded funds and facilities. The work paradigm asserted the difficulties of the business of investigating and creating sound, and the encapsulation of the musical work as a large-scale problem, incapable of solution except with the unparalleled computational power of a dedicated machine.

1.2 Ubiquitous mobile devices

Today things are very different, and I will briefly run through the comparison we all know, in order to reveal the nature of the issue I want to consider here.

I was woken up this morning by a small and immensely powerful computer sitting next to my bed, which I then popped into my jacket pocket as I left my room. It needs no air-conditioning, nor does it require any very specialist attention. As I leave, it alerts me to a message sent by my partner. Then, being uncertain about the location of the Onassis Centre, I use my fingers to negotiate the appearance of a scalable map of Athens on which I find my route - a small blue marker on the map follows my progress in real time. To calm my nerves I pop in my earphones and select a suitable piece of music to play as I walk - all on the same tiny, yet immensely powerful device.

This is an utterly different enterprise to that of historical computing. Each of these actions represents an enormous and complex set of computations, but those computational efforts are not the focus of the apparatus. They are ut-

terly transparent. I need know nothing, except to look and to point. This tiny computer is not an extraordinary version of the monster from 1976: it does not compute the results of my problems, so much as it connects and contextualises me in a network of data. This is not something remote from ordinary people: everyone has such a device - my friend in Africa has one. The possession of a particular make or model may indeed provide some prestige, but it is a prestige that is local and informal. The device is anyway a phone.

Those of us who saw personal computers at the start, who became addicted to keeping up to date, and who took pride in maintaining the fastest model we could afford are suddenly looking anxiously at a market place where new models are slow to appear. In the face of ubiquitous mobile technologies, will the computer - as such - even survive? The paradigm has shifted, and the network enfolds us. Far from presenting as slaves to our incommensurable desires, computers are now our points of connection within a network of social relationships and contingent information. What are the implications of this fact for music; for organised sound?

2. ORGANISED SOUND

The subtitle of this conference - From Digital Echos to Virtual Ethos - reminds us that sound has implications for human beings, and it is sound itself that I want to consider here. The word *echos* (ἦχος / ἦχη) implies sound in an unformed state "... of the confused noise of a crowd, the roar of the sea, the groaning of trees in a wind ..." according to Liddle and Scott. This is the meaning Michel Serres uses, in his book *Genesis*, when he writes about the fundamental medium within which human beings operate, taking the sea as source and metaphor –

The silence of the sea is an illusion. The sound of the depths could be the depth of being. Perhaps being is not at rest, perhaps is it not moving, perhaps being is agitated. The sound of the depths never ceases, is limitless, is continuous, perpetual, unalterable. It has no depth itself, it has no contradictions. What would have to be done with sound to impose silence on it. And what formidable fury can impose order on fury? Sound cannot be a phenomenon, all phenomena detach themselves from it, figure on ground, like a fire on the heath, like all messages, all cries, every call, every signal has to detach itself from the din that occupies silence, in order to be, to be perceived, to be known, to be exchanged. For a phenomenon to appear, it leaves the noise, as soon as a shape surges and positions itself, it reveals itself veiling the noise. So this is not about phenomenology, rather it is about being itself. It establishes itself as subject as much as object, as hearing and as spatial, as observer and as observed, it encompasses the means and the uses of observation, both material and systematic, in channels constructed or linguistic, it is in-itself, it is for-itself, it leaps over the the oldest and the most secure divisions of philosophy, yes, sound is metaphysical. [17] (this author's trans.)

Here we begin to understand sound and listening as dependent variables, mutually defining, equal in operation.

When, in a lecture given at Yale University in 1962, entitled, *The Electronic Medium*, Edgar Varèse coined the phrase "organised sound" he also encapsulated a defining approach to the nature of sound itself. For Varèse, sound appears as raw material from "a mysterious world", in an industrial environment where he describes himself as a "worker in rhythms, frequencies, and intensities." [20] The computer is the machine which, like the blast furnace and the mechanical hammer ensures that, "Composers are now able, as never before, to satisfy the dictates of that inner ear of the imagination.": design and make. This echoes an earlier manifesto, from June 1917, in which Varèse proclaimed -

I dream of instruments obedient to my thought and which with their contribution of a whole new world of unsuspected sounds, will lend themselves to the exigencies of my inner rhythm. [20]

This vision continues nearly a hundred years later in remarks made by one of the key figures in the development of computer music, Max Matthews, when he says, in a 2009 interview –

The question which is going to dominate the future is now understanding what kinds of sounds we want to produce rather than the means of usefully generating these sounds musically. [14]

Here the notion that the computer is capable of producing, "any sound you can imagine", echoing Varèse's desire for, "undreamed-of timbres" in "any combination I choose to impose" continues a rhetoric of control and domination that I want to question for a moment.

If, in its beginnings, the computer presents as a machine for the industrial manufacture of sound, what alteration to this paradigm is proposed by the existence of the network? Matthews in his 2009 interview continues, presciently as always, to propose that future of computer music, "... is going to revolve around experimental psychological studies of how the brain and ear react to sounds ...", and this raises the question of listening which is what I want to address next. How can we extend our understanding of the relation of sound to listening?

3. LISTENING

3.1 The Current of Music

Listening has been the subject of a considerable amount of discussion in recent years. Sociologists, neuroscientists, psychologists and cultural theorists have all reached the conclusion that listening, as a central phenomenon in human experience, is not as well understood as common sense would suppose. The common sense paradigm of listening is laid out clearly by Theodor Adorno, in his essay, *Current of Music*, where he writes –

The question of why we follow this descriptive or “phenomenological” method can easily be answered. We are dwelling on the phenomenon [“of music pouring out of the loudspeaker”] because it is actually the phenomenon which determines the reaction of the listeners, and it is our ultimate aim to study the listeners.” [1]

This places sound and listening in a teleological relationship that is at the heart of philosophical and scientific investigations of musical meaning and communication.

This relationship is also, as Jonathan Sterne points out, consolidated by the seeming directionality of the wires and speaker mouths of sound reproduction technologies, that, as Adorno agrees, appear to be aimed at the ears of the listener. Sterne writes –

The salient features of audile technique considered here - the connection of listening and rationality; the separation of the sense, the segmentation of acoustic space; the construction of sound as a carrier of meaning in itself; and the emphasis on physical, social, and epistemological mediation - are all fundamental to the ways in which people listened to and with sound-reproduction technologies, ... [19]

Here we have a paradigm in which sound and listening are independent and self-sufficient; where sound, as a phenomenon in its own right, is susceptible to the sort of design and control proposed by Varèse, Schaeffer and others, and where listening, as a decoding of meaning and affect for human purposes can be studied psychologically, sociologically and neurologically for our better understanding. Is there another paradigm for listening?

3.2 Ecologies of listening

Consider this account, by Penny McCall Howard, of the experience of working on a fishing boat in the North Sea -

A trawler at sea is also an incredibly noisy place and every sound is significant. Yet these sounds were interpreted not so much by listening as by extended techniques for feeling with the whole body, combined with a constant adjustment of tools, machines, and enormous weights and tensions. New crew needed an ‘education of attention’ (Gibson, 1979:254) in order to ‘feel the ground’ and react appropriately in order to ‘keep the trawl going’. They had to learn to distinguish the vibrations coming through the fishing gear from the ground from the constant noise and vibration of the engine, the whine of the electronics, and the shuddering and slamming of the boat itself in the waves. Fishermen use these techniques to work productively and also to develop complex descriptions and visualisations of what their fishing gear and the seafloor far below looked like. [8]

The critical phrase here is ‘education of attention’, a concept that comes from James Gibson’s ecological ap-

proach to visual perception [7]. This ‘ecological’ paradigm proposes sound and listening as much more curiously entwined: sounds are not just there for the taking, they have to be identified - constructed even - in an interplay between the phenomenon of the sound and the phenomenon of the listening. This formulation goes to the heart of what I am attempting in this talk, part of the consideration of ethos, which is an even-ing out of the hierarchies of the world in a way that places humans as no more than equal with other phenomena. Lest this sound too ‘hippy’, here is the psychologist Eric Clarke’s account of the ecological approach to listening-

Rather than considering perception to be a constructive process, in which the perceiver builds structure into an internal model of the world, the ecological approach emphasizes the structure of the environment itself and regards perception as the pick-up of that already structured perceptual information. The simple, but far-reaching, assertion is that the world is not a “blooming buzzing confusion”, but is a highly structured environment subject to both the forces of nature (gravity, illumination, organic growth, the action of wind and water) and the profound impact of human beings and their cultures; and that in a reciprocal fashion perceivers are highly structured organisms that are adapted to that environment. [3]

Like the fishermen in the trawler, who have to adapt to a sound world through an ‘education of attention’, Clarke proposes that we also have to attend and adapt to our sonic environment, and that this is not only a matter of contingent necessity, but is also an evolutionary process that has been happening since the start of human culture. Indeed from a cultural perspective, our ‘education of attention’ as musicians is a highly considered activity. As Simon Frith has pointed out, so-called art music is curious, as an area of life where people are taught how to listen in a highly institutionalised fashion. This listening *actually constitutes* sound, in the sense that our activity of listening in the world negotiates a territory. What is the territory of computer music?

4. TERRITORY

4.1 Sound of the earth

The notion of territory has been examined with some care by Gilles Deleuze and Felix Guattari [6], and clearly in the spirit of music. The child who cries, or the bird that sings establishes a social configuration of a space with its own materiality. In the words of Henri Lefebvre –

When we evoke ‘space’ we must immediately indicated what occupies that space and how it does so: the deployment of energy in relation to ‘points’ and within what time frame. [12]

This speaks to the particular relationship between music or sound and ourselves. It is clear that this relationship is indeed special and fundamental: the world, for example,

is not bathed in sound as it is bathed in light; there is no sonic equivalent of 'darkness', and the fact that we hear without the aid of a source of sonic 'illumination' gives sound an inherent energetic quality, un beholden to any extraterrestrial power source. Every sound is evidence of a particular vitality, and the provenance and impact of these vitalities create spaces that live and resonate in our personal and shared experiences.

In that sense a soundscape, so-called, consists equally of sound and listening. Its territory is established by the interaction of those two phenomena. One could even argue - as I have done elsewhere - that not only humans are listening. In that sense sound needs to be created, in a way different to what is imagined by Edgar Varèse: not just as something 'out there' but equally as a construct of the listener. Technology has a part to play in this, and the fundamental notion of the musical instrument - as the location of a practice of listening - proposes technological apparatus right at the heart of the human enterprise. What territories of sound and listening have established themselves in the age of electronic music?

In his recent book, *Earth Sound, Earth Signal*, Douglas Kahn describes the history of electrical communication from the middle of the 19th century in terms of the sounding potential revealed by new technologies. This, for example, is a description by Herbert N. Casson, of listening to a telephone line, published in 1910 -

Noises! Such a jangle of meaningless noises had never been heard by human ears. There were spluttering and bubbling, jerking and rasping, whistling and screaming. [...] There were clicks from telegraph wires, scraps of talk from other telephones and curious squeals that were unlike any other known sound. The lines running east and west were noisier than the the lines running north and south. The night was noisier than the day, and at the ghostly hour of midnight, for what strange reason no-one knows, the Babel was at its height. [10]

This new and fascinating engagement with sound arose not only through the invention of devices that could render electrical signals audible, but also through the interaction of those devices with the energies of the earth itself, creating a new frontier for the sonic imagination. The spread of commercial radio only extended this further.

4.2 Sound of the heavens

In 1961, first Yuri Gagarin from the USSR, then Alan Shepherd and later John Glenn from the USA, burst into outer space in manned rocket capsules. The American launches were broadcast live on radio, and I remember sitting by my primitive transistor radio with my headphones on listening to the countdown, pretending I was really taking part. The crackly voices, the static, the relay of the voices of the astronauts: these really were sounds from space. By the following year the first communications satellite, Telstar, had been launched into orbit, spawning the first hit single by a British band, The Tornados, to reach number one on the U.S. Billboard Hot

100. The pulsing signal from the satellite formed part of the intro, a sound we had all heard on the news, and the strange warbling of the electronic Clavoline, a version of the keyboard instrument developed by Constant Martin in the late 1940s, made the melody seem also from outer space.

By 1963, my family had acquired a television set, and one November evening we sat down to watch the first episode of a new BBC serial, Dr Who. I still remember it quite clearly; the school science lab, and the strange girl who seemed to know more about science than the teachers. How, after school, two of the teachers followed her back to her home, which seemed to be a blue Police Box sitting in a scrapyard. But the crucial things were the sounds: the extraordinary swirling and vaporous rhythms of the signature tune, and the terrifying, raucous pumping of the space-ship Tardis as it de-materialised. These were sounds not just of the imagination but related to my real experience of the æther; I had heard the sounds of the universe on the radio, and they bound my imagination closer to the science fiction of Dr Who, as they did to the weird music I had heard on the radio, by Karlheinz Stockhausen and Iannis Xenakis.

This little bit of personal history is useful because it connects certain elements of technology, sound and music in a way that reveals what I take to be crucial forces in the art of the last hundred years or so. Of the three technologies that have changed music beyond recognition - telecommunication, recording and digital computing - I would say it is auditory telecommunication that has most shaped our senses and our imaginations. Even radio static is not dead; it scintillates with detail, and every tiny move of the tuning dial reveals new sounds, human and cosmic. Sweeping the radio frequencies is like listening to a sort of aural telescope that gives us an immediate sense of the whole globe of our earth and the space beyond. Allegedly NASA was nervous about making public the first photographs of the whole earth taken from space because they thought the image would cause some sort of mass anxiety attack, and yet anyone with a radio had already heard the panorama of space, and its influence on music was immense. In the concert hall, audiences were shy of this new sound world, but in the incidental music to films and television, in the feedback, fuzz and distortion of the electric guitar in popular music, and at the heart of the avant-garde music of the 50s and 60s we heard the unmistakable territory of the new universe of sound opened up by electrical communication systems.

This radio universe is not just a macroscopic but also a microscopic universe: it is not just the static of the ionosphere, it is also the constructs of the transistors and capacitors that make up the radio set. The electronic components are embedded in a system that includes the world and the heavens, and when we listen in, we are able to participate with all those elements at play. In this context I would challenge the notion of 'sonic imagination' as some sort of industrial design process, prefigured by a free-ranging human creativity. I find it improbable that anyone can 'imagine' a hitherto unheard sound. What

19th century technology gave us was a set of technical devices and processes that fundamentally reorganised our listening. What is the digital echos? How do sound and listening get constructed in the world of the digital network?

5. THE DIGITAL *ECHOS*

5.1 The *mulch* of sound

One of the things about which Bruno Latour [11] has warned us is the danger inherent in the purification of our topics of investigation. Things are always hybrid, and the digital network is no exception. If the the nature of the fundamental sonic background is captured by Michel Serres in the presence and metaphor of the sea, the nature of the digital background can be conceived of as a jumbled amalgam of mobile devices, applications, data files shared and purchased, speeds of connection, distributed storage, nodes of interaction - both human and quasi-human, social aggregations of these nodes, and so on. Paul D. Miller characterises this as a “plagiarist’s club for the famished souls of a geography of now-here” [13], indicating his sense of a sort of aberrant temporality in the network. If Serres’ image of the sea seems stable and timeless, Miller’s view of the digital network is manic and grasping; still a sense of the infinite present but with an utterly different affect.

The currents of the sea and the currents of data make a neat comparison, but there are more than subtle differences. In particular, data is now subject to a sort of infinite storage and fragmentation, as files get backed-up and deleted successively across the network. So-called ‘cloud-storage’ and ‘cloud-computing’ mean that data and applications are no longer even integrated by the notions of presence or operation within a particular machine or system. They have become radically dispersed, and when their appearances are called-up their constituent parts remain like ghostly presences in the network.

This reminds me of Charles Darwin’s thoughts on the material nature of human culture. In his 1881 publication, *The Formation of Vegetable Mould, through the Action of Worms, with Observation on their Habits*, Darwin makes the singular claim that worms have played a defining role in human history, by effecting the process through which human artefacts are preserved. He writes -

(Worms protect) for an indefinitely long period every object, not liable to decay, which is dropped on the surface of the land, by burying it beneath their castings. [5]

This means that much of human culture depends for its very existence on tiny creatures which render an earth hospitable to humans, and which supports and preserves their buildings, rituals and artefacts. The mulch of the earth hides and casts up the background noise of life. Is there similarly a “mulch of data”, turned over by the applications, storage devices, human agents and social dynamics that constitute the digital network?

5.2 Malfunctions and refusals

This formulation purposively characterises the network as an amalgam of devices, protocols, data, power, flesh and blood humans - and by extension, animals and the physical world, in a configuration that is non-hierarchical with respect to its flows of energy. But the hybrid nature of the digital still proposes some crucial moments. As Richard Coyne reminds us -

Creativity has long wrestled with the machine, which in some respects has come to represent so much of what art is against: automation, control, reproduction, mindless copying, predictability, and of course capitalist production ... But there are also machines that are out of control, runaway devices, malfunctions, breakdowns, glitches. [4]

This reminds us not just of malfunctioning machines, but also of the power of malfunction itself: the digital network is not a free-flowing utopia of functionality, however hybrid. It is also subject to hacking and cracking, misuse and dismemberment. Its data flows can circulate but they can also be tapped and siphoned off, disrupted and held to ransom. As the digital network proposes a sort of globalised control, it proposes forces of resistance and subversion. We remind ourselves that while some artists have produced machines, computer software and interfaces at the cutting edge of technological development, there are others who have, for example, simply tossed a pile of cheap circuit components into a bowl of water and prodded them randomly with an electrical current to hear what happens.

6. *ECHOS AND MOUSIKĒ*

The Modernist narrative of the start of computing and computer music proposed an incremental progression of cost and efficiency, dictated by Moore’s Law, where cheaper, faster and smarter devices would lead inexorably to the sort of knowledge and understanding of sound, dreamed of by Varèse, that would produce an overflowing abundance of new music of hitherto unimagined beauties, through industrial processes of organisation. But Music - *Mousikē* - is not quite like that. In the dialogue, *Cratylus*, Plato shows Socrates searching for meaning by considering the origins of words in a sort of linguistic genealogy. At one point Socrates, in speaking of Apollo says -

The name of the Muses and of music would seem to be derived from searching and their making philosophical enquiries (μῶσθαί). [15]

Here Music is understood not as some sort of object or artefact, however intangible and transitory; nor is it the focus of a sort of craft or manufacturing. There is certainly a process at work, but that process is one of questioning and the forming of relationships: to search is to define and establish contact with an area, having a purpose in mind, but also open to the activity of reading. What has this area got to tell? As Tim Ingold reminds us -

Ever since Bacon and Galileo, nature has been thought of as a book that will not willingly give up its secrets to

human readers ... for medieval readers as for indigenous hunters, creatures would speak and offer counsel. [9]

This once again reminds us of a sense of agency that is evenly distributed, without favouring human participants. While I understand, and sympathise with, Varèse's need to find a new way of expressing what sound could be capable of, organisation proposes a sort of activity to which music has often remained resistant. Music searches in sound. It listens, in the sense of seeking to find and construct processes, images and affects. Music is open to what sound has to say. Music is the consequence of listening. I want to express this thought in this fashion, once again, to suggest gently that not only human beings are capable of agency.

In a paper presented to the UNESCO conference on "Music and Technology", held in Stockholm in 1970, Pierre Schaeffer, the founding father of *musique concrète*, also addressed the nature of this relationship between sound and music, in terms of the body's relationship to the tool: in his case the computer, for our purposes extended to include the notion of the digital network. Schaeffer characterises the nature of the collaboration between the musician and the other thing that makes the sound -

It is true ... that ... the more man communicates with the sound ... the more man communicates with himself. [16]

This presents the moment of music as a moment of self-realisation in sound, a moment which asserts the internal distance which allows a being knowledge of itself as an actor in the world. It proposes music first as a private, rather than a public act. But it also gives a powerful image of the human as constituted by relationships within a network and as determined by a response to the sounding world.

For Schaeffer, the network clearly involves the configuration of human beings and physical tools: in his case, one could say, the tape recorder and its technologies of tape. And in recent years a number of younger artists have rediscovered the originally moments of sound technology, in a moment of creative archaeology. I think for example of the renewed popular interest in radio and analogue synth ensembles, or the work of Aleks Kolkowski and others with wax and tin cylinder recording: an interest that has extended even into the popular domain in the recent releases by artists like Neil Young and Jack White. Is this a symbolic refusal of the digital?

There seems to me to be little evidence of any Luddite or reactionary tendencies here, but there is none-the-less an interesting extension of the hybrid nature of the network, which now abuts the digital and the analogue, the physical hand-skills of actual materials and the organisational and algorithmic skills of digital materials in ways that test the boundaries of sound's existence for us. This seeming backward step from the grand vision of ever more sophisticated computing presents as a stock-taking of how technologies and humans can interact.

7. WHAT IS SOUND?

In this talk I have tried to think through some of the implications of our current position in a history of music-making barely sixty years old. This history has unfolded under the sign of 'technology'; as if music has not always been a technological endeavor. But technologies change, and the computational devices that started this particular creative trajectory have transformed into actors in a more complex scenario. In the same way, our very notion of what an actor is has also changed, and this whole argument subscribes to a view propounded by Jane Bennett [2], Bruno Latour [11], Carey Wolfe [21] and others that seeks to flatten some of the hierarchies that have been constructed around humans and technologies, and to notice the hybrid nature of the resulting networks.

This flattening has some overtly political and ethical motivations, particularly in relation to the ecological and environmental issues that currently confront us. But I would argue that it also has some actually useful purchase on the necessary discussions around the nature and purposes of art, within a social context that is proving difficult for art, as we have formulated it, to engage with. As sound is the focus of our attentions, I want to conclude by wondering about the implications of such a flattening move for sound, and our future engagements with it.

In the context of this discussion, sound presents itself not as perceptual flow or a set of objects, 'out there' and available for human intervention, but rather as a network of disparate components, unfolding in time. The network contains, of course, vibrations or signals through a set of connected media, but also locations within those media that are themselves connected by constructions of space that are made by and contain agents, or actors. It is the roles and identities, both material and immaterial, taken by those actors, that help to define the nature of the network and its purposes, that are social, material, aesthetic or economic. The actors, so-called, can be wires, computer code, mobile devices, human beings and so on, each with some contingent agency. As with any network, this one can be tapped into at many places, and each point of tapping yields a different perspective on the nature of the network itself, its sonic presence, revealing its motives, its flows of reciprocation, its forces, affects and its spatial and temporal constructions. What I am trying to get at here arises out of a composition of machines, objects, physical phenomena, personae, people, social structures and tensions, and everything else that constitutes a site for action.

The purpose of this re-imagining of sound is to attempt a re-enchantment of our connection with it: to reassert that the relationships we establish with what we love cannot be one-way. Relationships pass to and fro in a communicative rhythm that attests to their health and vibrancy. As Serres asks, "What do we give back to the objects of our science, from which we take knowledge?" [18] Sound is a complex from which, in Tim Ingold's words, we should 'take counsel' in order to ensure that

our relationship with it and all its wonders continues to thrive.

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8. REFERENCES

- [1] T. Adorno, edited with an introduction by Robert Hullot-Kentor, *Current of music: elements of a radio theory*. Polity Press, 2009.
- [2] J. Bennett, *Vibrant Matter*. Duke University Press, 2010.
- [3] E. F. Clarke, *Ways of Listening: An Ecological Approach to the Perception of Musical Meaning*. Oxford University Press, 2005.
- [4] R. Coyne, *Cornucopia Limited*. MIT Press, 2005.
- [5] C. Darwin, *The Formation of Vegetable Mould, through the Action of Worms, with Observation on their Habits*. John Murray, 1881.
- [6] G. Deleuze and F. Guattari, trans. B. Massumi, "1837. Of the refrain," in, *A thousand plateaus: capitalism and schizophrenia*. Athlone Press, 1988.
- [7] J. Gibson, *The Ecological Approach to Visual Perception*. Houghton Mifflin, 1979.
- [8] P. M. Howard, "Feeling the ground: vibration, listening, sounding at sea," in, A. Carlyle and C. Lane (eds), *On Listening*. Cornerhouse, 2013.
- [9] T. Ingold, "Dreaming of dragons: on the imagination of real life," *Journal of the Royal Anthropological Institute*, vol. 19, no. 4, pp. 734–752, 2013.
- [10] D. Kahn, *Earth Sound Earth Signal*. University of California Press, 2013.
- [11] B. Latour, trans. C. Porter, *We have never been Modern*. Harvard University Press, 1993.
- [12] B. Lefebvre, trans. D. Nicholson-Smith, *The Production of Space*. Blackwell, 1991.
- [13] P. D. Miller, "In through the out door: sampling and the creative act," in P. D. Miller (ed.) *Sound Unbound*. MIT Press, 2008.
- [14] T. H. Park, "An Interview with Max Mathews," *Computer Music Journal*, vol. 33, no. 3, 2009.
- [15] Plato, trans. B. Jowett, *Cratylus*. Princeton University Press, 1961.
- [16] P. Schaeffer, "A propos des ordinateurs," *La Revue Musicale*, vol. 214-215, 1971.
- [17] M. Serres, *Genese*. Grasset, 1982.
- [18] M. Serres, trans. E. MacArthur and W. Paulson, *The Natural Contract*. University of Michigan Press, 1995.
- [19] J. Sterne, *The audible past: cultural origins of sound reproduction*. Duke University Press, 2003.
- [20] E. Varèse and C. Wen-Chung, "The Liberation of Sound," *Perspectives of New Music*, vol. 5, no. 1 (Autumn - Winter), pp. 11-19, 1966.
- [21] C. Wolfe, *What is Posthumanism?* University of Minnesota Press, 2010.