Astonishing sounds:
exploiting stones for a sonic poiesis

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Abstract: The profound connection existing between human beings, technology and non-organic matter is the one that has made our reality possible through centuries. In the modern era, the production of digital devices and chips relies heavily on minerals and rocks, but this connection is everything but contemporary. Humans have always mythologically interacted with stones and rocks more than with any other element they have been surrounded by. Such sensibility has been lost in time making needed a more holistic understanding of the interconnectedness of all living and non-living things on Earth. In this sense, the act of listening, more than the one of observing, generates an intense set of relations that requires attention, caring and continual negotiation and adaptation, suggesting a more empathetic vitality of perception. To convey a narrative that resonates with such sensory poiesis, the research is envisioning a novel and abstract acousmatic approach. Hereby, the literature of sonic exploration, both in sciences and arts, represents a critical foundation from which to start the study of new critical coordinates to design a retribalization of intents and behaviours towards nature. The research explores sounds and listening as elements to support and foster human sensibilities engaged with the complex challenges of contemporary life. The non-visibility of sound, its unseen qualities exploited through the rocks properties, can be used to explore, understand and design more ethical practices and interactions between humans and non-organic environments. By responding to environmental elements like ambient sounds, humidity, temperature and chemical compounds the unique microstructures of stones can open to a geomimicry approach establishing a low-fi holistic intelligence interchange between natural, non-organic materials, digital technology, and human behaviours, culminating in a novel perspective to design new abilities and hybrid innovations.

Keywords: Geomimicry - Non-organic Sensibilities - Human-Technology Integration - Digital Sensory - Hyper-objectivity - Non-human Ethics - Holistic Intelligence - Acousmatic - Critical Design - Retribalization

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Sensory premises

In the digital age, technology has fundamentally reshaped our sensory system, driven by its pervasive presence in our daily lives. In such contemporary landscape, our sensory experiences are increasingly intertwined with digital interfaces, giving rise to a new and evolving paradigm of perception. The most noticeable shift in our sensory system is, perhaps, the dominance of the visual sense. An overwhelming amount of visual information is delivered by screens of all sizes. Texts, images and videos create a visual overload that has led to a heightened reliance on our sense of sight, often at the expense of our other senses. Nonetheless, with the rise of streaming platforms, podcasts, and immersive audio technologies, our auditory sense has also taken its own stage. Noise-cancelling headphones and high-quality audio systems enable us to create personalised soundscapes, making our auditory experiences more immersive and customisable than ever before. The haptic feedback was introduced (Apple, U.S. Patent, 2013) [1] as a means of enhancing our tactile sense. Touchscreens, gaming controllers, and wearable devices in fact provide physical responses that simulate touch, adding a layer of interactivity to our digital interactions. This has blurred the lines between the physical and digital worlds and has marked a significant turning point underscoring the cognitive need to use the sense of touch to re-objectify the dematerialised technological elements. While the digital era has somehow expanded our sensory horizons, it has also brought challenges. Constant exposure to backlights of polarised nano-crystals and an overload of notifications and information delivered by portable and wearable devices has led to sensory fatigue and overwhelm. The rise of synthetic sensory experiences, from digital art installations to immersive gaming has evoked strong emotional and sensory responses, mistaking reality and simulation and stressing the human sensory system in a state of constant adaptation. While technology has expanded its sensory horizons and created new opportunities for engagement and immersion, it has

also posed challenges related, among the many, to sensory overload and loss of autonomy. This opening to the opportunity of some ethical and philosophical consideration on how we are deeply intertwined with the technology matter.

Organisms, rocks and technology

A profound connection, without which our contemporary reality would not be possible, exists and is the one between digital technology and non-organic matter. The production of digital devices and chips relies heavily on minerals and rocks. Silicon, extracted from sand, is a critical component in semiconductor manufacturing. Rocks and minerals play a crucial role in data storage technologies. Hard drives exist because of aluminium or glass. Rare earth magnets are fundamental in read/write heads. But this connection is everything but contemporary. Stone, a solid aggregate of one or more minerals or metals has been a vital resource since the inception of human civilisation. Throughout history, the use of rocks has had a huge impact on the cultural and technological development of humankind. A lithic technology used by humans for at least 2.5 million years. We could easily say one of the oldest and most consistently used technologies. A matter that more than any other has had, and still has, a mythical bond with humans. Many stories can be told about such a supposedly strong relationship between humans and stones. In an anthropocentric world, humans have always mythologically interacted with stones more than with any other element they have been surrounded by. Primordial cutting tools made from sharp-edged flakes. Large upright stones emplaced in the ground, measuring, shaping and culturally transforming the meaning of the space [2]. Enduring surfaces to communicate, symbolise and engrave lasting stories through symbolic signs. Bruno Latour observes, "The hammer that I find on my workbench is not contemporary to my action today: it keeps folded heterogeneous temporalities, one of which has the antiquity of the planet, because of the mineral from which it has been moulded" [3]. A non-mutual collaboration that was likely more evident in the past than it is in the contemporaneity but that contains a narrative that gives voice to primaeval elements, daily objects and inner forces. A trans-temporal fascination that has brought pebbles and rock samples found in rivers, oceans and karst to the pedestal of aesthetic and fascination (chinese Gongshi, japanese Suiseki, korean Suseok). From an object-making perspective, every-thing, whether contemporary or from the past, even when effectively representing choices being made in their present, is carrying a "map, backwards in time, to recognise the long histories they contain and forward over the centuries of their potential unfolding" [4]. Inorganic matter has been strictly bonded with the organic since what is called the Great Oxidation Event. A time in the Paleoproterozoic era when the Earth's atmosphere experienced the first significant rise in the concentration of oxygen. New mineral forms were generated due to a new chemical condition. No less the fossil incorporation of organic materials in sedimentary and metamorphic rocks. Moreover "humans walk upright over earth because the mineral long ago infiltrated animal life to become a partner in mobility" [4]. Rocks play also a crucial role in the process of carbon dioxide (CO_2) accumulation. A significant component

of the Earth's carbon cycle. While rocks themselves do not directly absorb or store CO_2 like forests or oceans, they are intimately connected to various geological processes that influence CO_2 levels in the atmosphere. Carbonate minerals including limestone, marble, and chalk, contain carbon in the form of calcium carbonate ($CaCO_3$). Carbonates form over geological time scales as the remains of marine organisms, like shells and corals, accumulate and undergo lithification. This process sequesters carbon from the atmosphere, effectively locking up CO_2 in rock formations. But rocks are subject to weathering, which is the breakdown of minerals on the Earth's surface. During this process, carbon dioxide from the atmosphere reacts with water to form carbonic acid, which can dissolve minerals in rocks. This process releases elements including calcium, magnesium, and silica, while simultaneously consuming atmospheric CO_2. This chemical weathering process helps regulate CO_2 levels in the atmosphere over geological time frames. Rocks provide a long-term reservoir for carbon. Over millions of years, geological processes like subduction, mountain-building, and erosion can transport carbon-rich rocks into different geological reservoirs, influencing the Earth's climate and the long-term carbon balance. While these geological processes are significant in the context of the carbon cycle, they operate on timescales far bigger than the human ones making it hard to get how "the metal, chemical, and mineral agents of history become pushed from mere contextual insights to agents of a different sort of genealogy" [5].

A sense for rocks

Speaking about timescales, anthropogenic activities as we know are much faster than geological processes. Such hyper-objectivity, with its attributes of non locality and distributed causality, transcends human grasp creating a blurred area of comprehension of the complex interconnectedness of the world, distorting effects across distances and timescales. Additionally, causes and effects are distributed across multiple agents and systems, making it challenging to attribute them to a single source or event. That's why a more holistic understanding of the interconnectedness of all living and non-living things on Earth is crucial. Its comprehension challenges human-centric perspectives and encourages a more inclusive view of the environment that could only be reached by detaching from an observer-independent standpoint attitude. Such sensitivity is a more profound and philosophical alteration of human sensitivity in relation to their objective reality. A sensitivity to non-human ethics enabling to see the environment as a whole. Considered as the application of knowledge for practical purposes, technology represents our relations with the Earth "mediated through technologies and techniques of visualisation, sonification, calculation, mapping, prediction, simulation, and so forth" [5]. And also the instrument with which humans have impacted the Earth. In Bruce Clarke's words, "from the co-evolution of living systems with the totality of their terrestrial environment, Gaia emerged as a meta-system of planetary self-regulation maintaining viable conditions of atmospheric composition, temperature, oceanic pH and salinity, and of the global distribution of organic nutrients such as nitrogen, sulfur, and potassium. The biosphere performs like any living organism

with a complement of homeostatic feedback mechanisms for maintaining geo-physiological functions at healthy levels. Gaia theory is an indispensable framework for thinking about global climate change because it is only by recognising Gaia's multi-systemic self-regulation that we can fully understand what we are now facing the imminent failure of those regulating systems". [6] With such premises, an exploratory, design-driven, work has been conducted in order to explore a new realm of sensitiveness. An approach based on a primitive re-connection between human beings and Earth. Between their senses and the inner non-organic forces of nature. If sensitivity passes through human capabilities and ethics, the research has focused on exploring the non-organic sensory capabilities of rocks as a medium of reasoning about human sensory scenarios. The dominance of a visual-centric environment, artificial noise pollution, technological isolation and social behaviour shifts have detached humans from an auditory connection with nature, with its vibrancy flows and reverberance. In this research, sound has been explored in its core meaning resulting from mechanical vibrations travelling through a volatile, liquid or solid medium. Hidden frequencies and infra-sonic energies create vibratory models that are very common representations and understanding of the environment among animals and plants, but more in contrast with the representational human codings stuck on the visual surface. Considering these factors, the research explores sounds and listening as elements to support and foster human sensibilities more than capacities that are engaged with the complex challenges of contemporary life. The non-visibility of sound, its unseen qualities, may be used to explore, understand and design more ethical practices and interactions between humans and non-organic environments. Through a more immersive and abstract auditory experience, this acousmatic approach is intended to convey a narrative that resonates with the research's premises around senses.

Sonic exploration

As a critical foundation of the work, there is a set of sonic explorations and art experiences that have scripted the basis of digital sound practices and electroacoustic techniques. Crucial is a set of experiences about the usage of electronics and technology to manipulate, process, and spatialise sounds like synthesisers, computers, sensors and digital processing software. The activist sound collective Ultra-red, in its artistic production, puts a particular emphasis on aesthetic forms whose political content does the work of both cultural analysis and cultural action. Such work pursues a fragile but dynamic exchange between art and political; sounds and listening are used as ways to address political subjects specifically around supporting communities in conflict by the thinking that the act of listening is deeply connected with the one of dialogue. What particularly resonates from their work are the intertwined concepts of overhearing and invisibility connected with the concept of the stranger and the ones who may not be seen. In such an approach, "sound is moving away from a source, to circulate and propagate through environments, and through matters and bodies, deeply linked to expressions of migration and transience" creating alien languages as inter-lingualism settings [7]. The taking for the research is the concept of

weakness; particularly of sound as an object of study and perception. Weakness mainly intended in its experiencing through the time because sound must be repeatedly played to capture its density and impact. It evades the capture of the senses more than the images can. And is effectively such weakness that as to be put forward as a position of strength. This idea of vulnerability and fragility can hold intrinsic value. Is by embracing our weaknesses that we could lead to personal growth, ethical development, and a more compassionate society, underscoring the interconnectedness of all forms of life and matters. The design research in this field helps with a deeper understanding as well as with leveraging visibility, of what Hannah Arendt terms "the space of appearance", not in the sense of a visual representation but more with a hinged and focused engagement by moving in and around what we see with the fluctuating practice of listening. In this sense, listening becomes the medium for a deeper view and empathy with our inorganic surroundings, reinforcing the "material intensities of things around us while relating this to the spectralities of what is missing or held behind the "screen" of the real" [7].

By viewing sound as a phenomenon that exists between an object and its expansive influence, an inherently ambiguous state where elements of the world come to life and disperse in every direction, we can generate a means to move design in the direction of enhancing such connections. Through the design discipline, sound opens up extensive opportunities for interaction and dialogue within the realms of organics and non-organics by traversing the realms of objects and bodies, subjects and things. This approach disrupts, through frequencies and vibrations, the conventional notion of the human body as a central and dominant entity. Instead, it positions the human body within a dynamic network of life forces where alliances, conflicts, interconnections, and exchanges are in a constant dynamism, spanning mutually from bodies to species and entities [8]. Sounded actions significantly expand the boundaries of both organics and non-organics, transforming them into dynamic channels of expression, where intersections and convergences, as well as divisions and disruptions, become possible. Sound amplifies relationships by unleashing their inherent potential, bringing the elements and entities of the world into contact with each other. Developed during the rise of electronic culture, Marshall McLuhan's concept of an extended nervous system (the media) not only provides valuable insights into the forms and pathways of global connectivity but is also instrumental in highlighting how relationships within a network are subjected to novel systems of perspectives in which every element could be considered as an overheard subject. "In this electric age, we see ourselves being translated more and more into a form of information, moving toward the technological extension of consciousness. The extendedness of consciousness occurring due to electronic networking and automation produces another bodily configuration and sensibility from which we become intensely aware of the lives of others, and from which a "decentralised and inclusive" social formation takes shape" [9]. In this way, circumstances and encounters influence the act of overhearing in relationship with the capturing possibilities and the interference of noises. Furthermore what is heard is not usually and solely perceived because of proximity. A new set of critical coordinates is needed to approach to the theme of hearing in a sort of retribalization of intents and behaviours.

Listening ethics

The act of listening, more than the one of observing, indeed, generates an intense set of re-lations that requires attention, caring and continual negotiation and adaptation, suggesting a vitality of perception that is more oscillatory than pictorial [10] and that could be carried by new listening devices designed as agents of understanding and leveraging the poten-tials of matter-energy interaction. The immateriality of sound vibrations and frequencies, more than the ones from light and colours, brings with it the concept of movement and correlations. With this in mind should be created the conditions in which to redraw how we acknowledge our relationship with the Earth and foster an ethics of balanced relation-ships and dynamics. Such a new approach to reality is supported by a more inclusive and democratic way of understanding it. As Harman says "the true chasm in ontology lies not between humans and world, but between objects and relations" [11]. Objects, whether physical or abstract, have their intrinsic properties and agencies, and they interact with each other independently in an ontological egalitarian relationship. In its essence, sound is a dynamic interplay of physical vibrations and the medium through which it travels. David Thoreau defined it as Sphere Music when he wrote that "some sounds seem to reverber-ate along the plain, and then settle to earth again like dust; such are noise, discord, jargon. But such only as spring heavenward, and I may catch from steeples and hilltops in their upward course, which are the more refined parts of the former, are the true sphere music –pure, unmixed music– in which no wail mingles [12]. Originating from physical move-ment or vibrations, such sound, is fundamentally a mechanical process. Thoreau sounds were aeolian sounds heard on the outside, while if our objectives are sounds audible from the inside, like electrosonic manifestations of naturally occurring energies, their percepti-bility varies and requires transduction to be heard. More precisely, when we approach any exploration of sounds connected to non-organic matters "that electromagnetic fields and waves require technology for transduction into sound means that they have been occluded by mechanisms of control" [13]. This means that if it is easy to hear a sound from nature, like a bird singing, is less immediate to perceive a signal from nature, like electromagne-tism. The first touch with such a kind of source was experienced in the early nineteenth century throughout the first telecommunication systems interacting, or better interfering, with the environment and giving back odd environmental sounds. As André Breton says, the sky is only an antenna with a wide range. An abiotic nature begins to be perceived in its inner vitality due to physical sciences starting to deal with a new materiality of sound. Earth currents as well as atmospheric energies arise as mysterious sounds through pho-nographs, radios and telegraphs in the same way with which invisible microorganisms come to the eye through microscopes. What was invisible before gets magnified making it audible with astonishing loudness giving start to a fascinating journey that spans over a century, marked contextually by technological innovations and artistic experimentation. Any exploratory work around the sonic properties of the lithic matter necessarily means, then, to be in-circuit with larger environmental sources, in circuit with the Earth. Sounds and signals combined become, through a series of electronic music explorations, the way to perceive nature, but mostly a way to reconnect and hyper-connect humans and nature. A pioneering exploratory work of acoustic phenomena comes from Alvin Lucier. His in-

fluence on the development of contemporary music has moved from a deep exploration of acoustic phenomena and sound properties. Lucier's works mostly focus on the interaction between sound, space and technology. He has explored how sound behaves in different environments and how it can shape our perception of space. One of Lucier's most famous and groundbreaking compositions is "I Am Sitting in a Room" (1969). In this piece, he recorded himself speaking a text and then played the recording back into a room while re-recording it. This process was repeated multiple times, causing the sound to resonate and transform with each iteration, ultimately becoming an ethereal and abstract composition. His extensive body of work, exploring the relationships between sound, space, technology, and human perception, has pushed the boundaries of what is possible in the realm of experimental music and sound art but is also a consistent reference for any design approach that aims to explore the sensory qualities of matter. Another radical exploration of sound comes from the works of John Cage. His experimental approach to sound and art is fascinated by the idea of incorporating chance and indeterminacy into music like in his work Fontana Mix, of 1958, where the score consists of a series of transparent sheets that can be overlaid in different combinations, creating a unique score for each performance. In Prepared Piano, of 1946, various objects, such as screws, bolts, and rubber pieces, are placed between the strings of a grand piano altering the instrument's timbre and creating a unique and percussive sound. Cage's overall artistic sensibility was profoundly influenced by an experience of auditory interoception he perceived by his nervous system visiting an anechoic chamber at Harvard. In 1965 he explored the use of brainwaves as a source of sonic material in the composition Music for Solo Performer in which he collaborated with the composer and neurologist David Tudor to create a piece where Tudor's brainwaves, measured by an electroencephalogram (EEG), were used to trigger electronic sounds. This makes clear that to conceive perceptual experiences that bridge the gap between the biological and synthetic realms, the designer must grapple with the diverse outcomes of technologies, matter and their interaction with bodies and environment. In his book "Hyperconnectivity," Adrian Cheok examines the technologies and products that enable complex relationships to be established through the web among people and between people and technological artefacts to assess their social and economic impact [14]. According to Cheok, hyperconnectivity will prove to be one of the most important foundations of sustainability because it amplifies the potential for collaborations among machines, people, and things. People, immersed in a cloud of data, interfaces, and algorithms, are destined to live in a persistent nomadic mode between physical and digital environments. This point of view perfectly resonates with the body of work from Gordon Mumma who, incorporating seismic data from earthquakes and underground nuclear testing into his music, in the early 1960s pioneered a new approach to the relationship between sound frequencies and Earth where geological phenomena become a source of inspiration and sonic exploration. After acquiring data collected by seismometers and represented graphically as seismograms, he started interpreting data looking for patterns, and rhythms as well as exploring complex waveforms and variations in amplitude over time. Transforming those numerical values into audible sound, assigning pitches, durations, and other musical attributes to the data points, Mumma challenges to sonify avant-garde compositions. This exploration of underground sounds proves that earthquakes and other seismic events possess an acoustic

nature which remains beyond auditory perception through sub-audible sounds that traverse from one end of the planet to the other, unnoticed by our ears.

Acoustic sensory forms

Fundamental to understanding the generation and propagation of sound in various contexts, including music, engineering, and physics is the concept of resonance and resonant bodies. Physical objects have inherent resonant frequencies at which they vibrate in a natural resonance determined by the object's material properties, size, and shape. Phenomenon well known in engineering and architecture as a fundamental research field to control and avoid structural issues or failures. In physics, resonance plays a role in nuclear magnetic resonance (NMR) spectroscopy and magnetic resonance imaging (MRI). When it comes to concepts related to sound and vibrations, resonance is quite well known as a property of physical systems or objects and can be observed in various contexts, including musical instruments, structural engineering, and acoustic phenomena. Piezoelectricity, on the other hand, is a unique property of certain materials that can generate an electric voltage when subjected to mechanical stress or pressure and, conversely, can deform when an electric field is applied to them. It has been diversely used in intriguing applications in the realms of art, music and design enabling interactive experiences in which sensors capture vibrations that can be manipulated.
Early in the 1920s, Léon Theremin developed, based on piezoelectricity, an instrument producing unique and eerie sounds, the Thereminvox. Using electronic oscillators consisting of a vertical antenna which controls pitch and a horizontal loop antenna controlling the volume, it operates on the principle of capacitance and can produce both melodic and atonal sounds. It remains an iconic and enigmatic instrument in the world of music and technology and had a profound influence on the development of electronic music and the synthesiser as well as more recent design experiences like Playtronica and TouchMe that, by enabling the understanding and self-creation of soundscapes through conductive materials and sensors and their interaction with objects and humans, has reopened interest and curiosity. Nonetheless, sensors integrated into clothing and wearables respond to body movements and interactions, producing sound or light displays, thereby blurring the boundaries between art, fashion, and technology and introducing new dimensions of sensory engagement. The Design Academy Eindhoven and Synthux.academy has launched a project aiming to discover unconventional designs and exploratory user experiences with a collection of human-centred synthesisers. The project, which name is Make it Sound, explores the definition and the redesign of traditional instruments bridging the analogue and the digital to create soundscapes. The exhibition event is designed as an interactive space in which people become part of a communal creation and explore complex sound typologies via synths design. Sound based projects show a recalling attraction between humans and the complex realm of frequencies, vibrations, and inner energies that constantly surrounds everything.

For an affective sensory materiality

> *It is not a white noise of screeching, chaotic qualities demanding to be shaped by the human mind, but rather a black noise of muffled objects hovering at the fringes of our attention* (G. Harman, 2005) [15].

Exploring non-organic materials and their intimate connection with our history, our being, our sensibility, our deep and, at the same time, pale connection with those elements that we consider inanimate this research aims to start an exploratory understanding of how senses can, hermeneutically, take back a more sensible and compassionate role in the construction of a better-balanced relationship with our surroundings and become a more complex medium of understanding and interaction with the reality we live in. In this sense, listening is more than simply hearing with the ears. It includes the body and all the senses. It also includes listening to and through the technology. Listening to intuition, to messages we may not be able to place beyond technology or beyond our habits. This is even more urgent in a contemporaneity where trans-connectivity is going beyond expectations at a speed that overcomes the needed time for any epistemology capable of leading the development of an ontology and an ethic about living hyper-connected. Human power is itself a kind of thing-power, as Jane Bennet states, and while it is easy to acknowledge that humans are composed of various material parts (the minerality of our bones, the metal of our blood, or the electricity of our neurons), it is more challenging to conceive of these materials as lively and self-organising, rather than as passive or mechanical means under the direction of something nonmaterial, that is, an active soul or mind [16]. Such a statement sets the point of perspective. The organic power of humans is dealing with the inorganic reality that itself has created, sensing our non-organic side and understanding how to embrace a common fate by directing the design practice toward a more conscious and ethical approach. On a more practical level, this means, beyond any ethical and philosophical consideration, the need to start exploring different qualities and properties of the inorganic matter. To test and understand which perspectives can become the ones that more resonate with the construction and production of a balanced reality. Still, Bennett emphasises the vibrant materiality of non-human entities within the concept of assemblages. This perspective recognises that non-human elements, such as objects or natural forces, possess a form of agency and vitality that can influence events and interactions. An assemblage, in Bennett's framework, is a dynamic and heterogeneous gathering of diverse elements, both human and non-human, that come together and interact within a particular context. These elements can include objects, living organisms, non-organic elements, as well as ideas and technologies. Central to the concept of assemblage is the idea that agency is not solely the domain of individual human actors. Instead, agency is distributed across the assemblage's various components in which each element contributes to its overall actions and effects, emphasising multiplicity and complexity, challenging traditional notions of singular, isolated agency. Core in this perspective is also the concept of affects and affordances within assemblages, where affect refers to the emotional and sensory qualities of elements in an assemblage, while affordance pertains to the opportunities for action that these elements offer because assemblages are characterised by affective and

perceptual qualities that shape the relationships and behaviours of their components. In this sense, such thinking encourages a reevaluation of our ethical and political commitments, emphasising a sense of interconnectedness and interdependence, offering a novel perspective on the dynamic interplay between human and non-human entities.

Research following the idea of nature as a model is a common trans-disciplinary practice leading to designs and processes that have taken advantage of a long-lasting experienced innovation by nature's finest problem-solving strategies and optimisations. Such nature's mentorship is commonly based on organic behaviours that deal with cells and surfaces chemical structure and physical properties as well as optimised shapes and adaptive solutions to the environment. Extending the concept of mimicry beyond the biological realm to include geological and Earth-related processes and structures opens the possibility of addressing new challenges by emulating geological formations and Earth's processes. Such an approach unveils a profound exploration of humanity's relationship with the Earth and the philosophical underpinnings of how we engage with the natural world. It certainly raises questions about the consequences of our detachment from the Earth's rhythms. Involving the emulation of geological processes and systems encourages a philosophical exploration of complexity and systems thinking, and challenges us to rethink our temporal horizons. Geological formations like tuff, basalt, and sandstone constantly and silently interface with a myriad of environmental variables encompassing ambient auditory signatures, humidity levels, temperature fluctuations, and chemical compositions. These stony entities unveil a remarkable repertoire of sensory aptitudes. Latent capabilities that can be artfully harnessed through the strategic deployment of contact microphones and microphone arrays, heralding the advent of an avant-garde domain where adaptive soundscapes seamlessly intermingle the analog and the digital, as well as the organic and the technological. The perspective of this reflection is to delve into the acoustic perceptive potential latent within rocks, including but not limited to tuff, basalt, and sandstone, by employing sophisticated techniques of sound detection and generation. Capitalising on the innate responsiveness of these stones' microstructures to environmental frequencies, ingenious processes should emerge, such as adaptive acoustic masking. This process undertaking, therefore, embarks on a mission to cultivate a form of sensory interplay that thrives on low-fidelity interactions, fostering a dynamic convergence of elements that encompass natural, non-organic materials, digital technologies, and the intricate tapestry of human behaviours. As a conceptual framework, the aspiration is exploring nature mimicking through an orthographic approach with a different perspective on how we understand and represent the sonic world. Above all, embracing a non-hierarchical attitude, where all entities, whether human, non-human, living, or non-living, are considered equally important and are represented in a flat, interconnected manner. Is also crucial to question the role of representation in shaping our understanding of the world and highlight the limitations and biases inherent in representational practices, this mainly because existing entities are not dependent on human observation or interpretation. By recognising the agency and existence of non-human entities, *ontography* also leads to a reevaluation of our ethical responsibilities toward the environment, technology, and non-human beings; it needs a new way of looking at the phenomena. Creating an *ontography* for the objects involves observing, cataloguing and reasoning about things, drawing attention to the couplings

of and chasms between them [17]. In this sense, an intentional approach to redefine and design practices centred on emotional and sensory qualities of elements ought to manifest as a multifaceted sensory encounter, one that, through the process of design, not only activates but also fortifies a more extensive, if not entirely alternative, experiential framework. The digital environment has enhanced systems capable of transcending the physical and temporal limitations of matter and space. In some cases, physiological components closely related to the biological complexity of human sensory perception are lacking in a hyper-digitised contemporaneity. The design is called upon to interpret this intersection of sensory and emotional experiences by designing artefacts that can explore and expand the opportunities offered by deeper and interactive exploitation of technologies and natural behaviours. Design should explore an alternative sensory approach that does not look back in an attempt to remain anchored to a presumed completeness of the human experience but challenges the discipline to "incorporate integrated human segments with technical combinations" [18]. Lastly, it requires reflection and investigation to evaluate and strategically manage an alternative aesthetic system that hybridises organic and non-organic sensibilities, intimately reconnecting them to the physicality of the body and its receptors, while simultaneously stimulating and enhancing new sensitivities and emotions. If we build cognitive maps through perception, these are nothing more than a personal interpretation of a more complex and largely unexplored territory. In this territory, cerebral functions transcend the realm of the calculable and tend toward an unconscious yet complex evolutionary model that materialises in resistance to algorithmic translation. In this direction, the challenge for design is precisely to apply its unique critical approaches to a convincing system of hybridisation.

A *Digital Gongshi* for an adaptive hybrid sensing

> *I knock at the stone's front door.*
> *"It's only me, let me come in. I hear you have great empty halls inside you,*
> *unseen, their beauty in vain, soundless, not echoing anyone's steps. Admit*
> *you don't know them well yourself* (W. Szymborska, 1962) [19].

The *Digital Gongshi* is a symbolic idea, a non-object which aims to generate a hybrid and holistic intelligence that responds dynamically to environmental conditions geo-mimicking sonic attributes of stones' structures. A two-way flow of informations interacting with the environment resembling the complex sonic properties exhibited by various types of rock structures including resonance frequencies, damping effects, and propagation characteristics. Holistically integrating elements of machine learning and artificial intelligence to optimise the understanding and the responses from environmental stimuli, the project generate adaptive behaviours leveraging the unique sonic attributes of rocks microstructures. Using such holistic intelligence of stones involves recognising and leveraging the interconnected aspects of their physical, energetic, and symbolic properties. Stones interact with their environment through processes like erosion, weathering, and geologi-

cal formations. Appreciating their symbolic significance means considering how stones influence and are influenced by their surroundings. By working on a database of different stones and rocks structures, it reproduces, adapts and creates new peculiar properties; record audio samples of stones to capture their sonic signatures; analyse the audio data to identify frequency, resonance, and other sonic characteristics; implement interactive features that allow to explore and reinterpret environmental stimuli. The project draws from the principles of geomimicry and sonic ecology to create an interactive sonic landscape that evolves in real-time, reflecting changes in the environment and fostering a deeper connection between individuals and their surroundings. Key elements of the project are a sonic mimicking of propagation patterns in rocks structures; an environmental sensitivity integrating sensor technologies which data inputs inform the sonic environment and influence its tonality, volume, and spatial distribution; adaptive intelligence algorithms of real-time processing for a dynamic adjustment enabling the environment to evolve and respond in sync with its surroundings; a virtual materiality attitude experimenting with AI generated novel micro-structures enabling complex acoustic properties. Conceptually it emphasises on viewing intelligence not only as cognitive ability isolated from emotional or intuitive processes, but rather as a cohesive and integrated whole that encompasses multiple dimensions of human awareness and interaction with the world and involves the capacity to adapt thinking patterns and problem-solving approaches across different domains and contexts. It focus on cognitive flexibility as a new approach to problem solving and holistically emphasise a systemic thinking perspective recognising the interconnections and interdependencies within complex systems.

Hybrid perspectives

Looking at the way humans interact with the environment they inhabit, the "human-dominated" geologic epoch seems much more a product of chance and unconsciousness than of a proper control of the global material [20]. The inner energies and qualities of everything surrounding us are far from being perceived and understood in their totality. They are mostly valued unidirectionally with the only reference to exploitation without any conscious grasp on their inter-objectivity [21]. These hyper-objective phenomena transcend human comprehension due to their non-local and distributed causality characteristics, making it challenging to attribute their effects to single sources or events. A more holistic understanding of the interconnectedness of all living and non-living entities on Earth is certainly a key way to understand this inter-objectivity. Certainly, it challenges any human-centric perspective and promotes a more diverse point of view that detaches from the concept of an observer-independent standpoint. The research outlines an exploratory, design-driven endeavour aimed at re-establishing a sort of primitive connection between humans and the Earth, particularly through the exploration of mutual sensory capabilities. In a world dominated by visual-centric environments, artificial noise pollution, technological isolation, and shifting social behaviours, this research explores sound as a medium for reconnecting humans with nature's vibrancy and reverberance. It delves into the core

essence of sound as mechanical vibrations. The exploration of hidden frequencies and infra-sonic energies aligns more closely with the sensory models of animals and plants, offering a departure from human visual codings. In this context, the research advocates for sound and listening as vehicles to enhance human sensibilities rather than just capacities, particularly in addressing contemporary life's complex challenges. By highlighting the non-visibility of sound and its unseen qualities, the research suggest that an acousmatic approach can lead to more ethical practices and interactions between humans and the environment. The intent is to inform a research approach on a global view of energies in which an abiotic nature is associated with the physical sciences and with a materiality often assumed to be immaterial [22]. The research have moved between two realms of knowledge about things, on one side the what they are made of and on the other the what they do [23]. The objective is not to limit exploration solely to its individual components but to shift the focus of research on objects from mere materialism to a more intricate network of interrelations. On a practical level, it requires acknowledging the vibrant materiality of non-human entities within the concept of assemblages, wherein objects or natural forces possess a form of agency and vitality that can influence events and interactions. In such an assemblage, agency is not the exclusive domain of individual human actors; it is distributed across all the components, emphasising multiplicity and complexity over traditional notions of singular, isolated agency. By responding to environmental elements like ambient sounds, humidity, temperature and chemical compounds the unique microstructures of stones can open to a geomimicry approach establishing a low-fi holistic intelligence interchange between natural, non-organic materials, digital technology, and human behaviours, culminating in a novel perspective to design new abilities and hybrid innovations; and to nudge that Responsible Innovation for which it is essential to maintain a continuous focus on the broader impacts of the new technologies and to comprehend the interconnections between humans, their communities, and their environments [24] -both organic and non-organic- to generate a new set of adaptive and responsible behaviours and patterns. Further aim is to encourage a reevaluation, through design-driven practices, of ethical responsibilities toward the environment, technology, and non-human beings. In this sense, an intentional approach to redefine and design practices centred on emotional and sensory qualities of elements should manifest as a multifaceted sensory encounter, activating and fortifying a more extensive, if not entirely alternative, experiential framework.

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Resumen: La profunda conexión existente entre los seres humanos, la tecnología y la materia inorgánica es la que ha hecho posible nuestra realidad a lo largo de los siglos. En la era moderna, la producción de dispositivos digitales y chips depende en gran medida de minerales y rocas, pero esta conexión es todo menos contemporánea. El ser humano siempre ha interactuado mitológicamente con piedras y rocas más que con cualquier otro elemento del que se haya rodeado. Esa sensibilidad se ha perdido en el tiempo, haciendo necesaria una comprensión más holística de la interconexión de todas las cosas vivas y no

vivas de la Tierra. En este sentido, el acto de escuchar, más que el de observar, genera un intenso conjunto de relaciones que requiere atención, cuidado y una continua negociación y adaptación, lo que sugiere una vitalidad más empática de la percepción. Para transmitir una narrativa que resuene con dicha poiesis sensorial, la investigación prevé un enfoque acústico novedoso y abstracto. De este modo, la literatura de exploración sónica, tanto en ciencias como en artes, representa una base crítica desde la que iniciar el estudio de nuevas coordenadas críticas para diseñar una retribalización de los intentos y comportamientos hacia la naturaleza. La investigación explora los sonidos y la escucha como elementos de apoyo y fomento de sensibilidades humanas comprometidas con los complejos retos de la vida contemporánea. La invisibilidad del sonido, sus cualidades invisibles explotadas a través de las propiedades de las rocas, pueden utilizarse para explorar, comprender y diseñar prácticas e interacciones más éticas entre los seres humanos y los entornos no orgánicos. Al responder a elementos ambientales como los sonidos ambientales, la humedad, la temperatura y los compuestos químicos, las microestructuras únicas de las piedras pueden abrirse a un enfoque geomímico que establezca un intercambio de inteligencia holística de baja fidelidad entre materiales naturales no orgánicos, tecnología digital y comportamientos humanos, culminando en una perspectiva novedosa para diseñar nuevas habilidades e innovaciones híbridas.

Palabras clave: Geomímesis - Sensibilidades no orgánicas - Integración humano-tecnología - Sensorialidad digital - Hiperobjetividad - Ética no humana - Inteligencia holística - Acusmática - Diseño crítico - Retribalización.

Resumo: A profunda conexão existente entre os seres humanos, a tecnologia e a matéria não orgânica é o que tornou nossa realidade possível ao longo dos séculos. Na era moderna, a produção de dispositivos digitais e chips depende muito de minerais e rochas, mas essa conexão é tudo menos contemporânea. Os seres humanos sempre interagiram mitologicamente com pedras e rochas mais do que com qualquer outro elemento que os cercasse. Essa sensibilidade se perdeu no tempo, tornando necessária uma compreensão mais holística da interconexão de todos os seres vivos e não vivos da Terra. Nesse sentido, o ato de ouvir, mais do que o de observar, gera um conjunto intenso de relações que exige atenção, cuidado e negociação e adaptação contínuas, sugerindo uma vitalidade de percepção mais empática. Para transmitir uma narrativa que ressoe com essa poiesis sensorial, a pesquisa está prevendo uma abordagem acústica nova e abstrata. Assim, a literatura de exploração sônica, tanto nas ciências quanto nas artes, representa uma base crítica a partir da qual se inicia o estudo de novas coordenadas críticas para projetar uma retribalização de intenções e comportamentos em relação à natureza.
A pesquisa explora os sons e a audição como elementos para apoiar e promover as sensibilidades humanas envolvidas com os complexos desafios da vida contemporânea. A não visibilidade do som, suas qualidades invisíveis exploradas por meio das propriedades das pedras, podem ser usadas para explorar, compreender e projetar práticas e interações mais éticas entre humanos e ambientes não orgânicos. Ao responder a elementos ambientais como sons ambientes, umidade, temperatura e compostos químicos, as microestruturas exclusivas das pedras podem se abrir para uma abordagem geomimética, estabelecendo

um intercâmbio de inteligência holística de baixa fidelidade entre materiais naturais e não orgânicos, tecnologia digital e comportamentos humanos, culminando em uma nova perspectiva para projetar novas habilidades e inovações híbridas.

Palavras-chave: Geomimética - Sensibilidades não orgânicas - Integração homem-tecnologia - Sensorial digital - Hiperobjetividade - Ética não humana - Inteligência holística - Acústica - Design crítico - Retribalização