

## Chapter

# Mediating the More-than-Human: Intermedial Semiotics and Multimedia Ecologies in AI-Driven Environmental Art

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## Abstract

This chapter examines the intersections of intermediality, semiotics, and multimedia in the context of contemporary environmental art installations that employ digital technologies and artificial intelligence (AI). It argues that while multimedia provides the technical platform for integrating diverse modalities – sound, image, data, and interaction – intermediality offers a critical framework for understanding the semiotic transformations that occur when these modalities translate and reshape one another. The concept of multimedia intermedial ecologies is introduced to capture this convergence, emphasising that the ecological mediation enabled by AI-driven environmental art is not merely representational but performative and operative, involving distributed agencies across human and more-than-human domains, and highlighting the capacity to engage with hyperobjects that exceed human perception. The chapter develops the concept of multimedia intermedial ecologies through case studies that include *The Great Animal Orchestra*, Andrea Polli's *Heat and the Heartbeat of the City*, the collaborative project *Oceans in Transformation*, BioArt like Eduardo Kac's *Genesis* and Anicka Yi's *In Love with the World*, and robotic exploration in Bill Vorn and Louis-Philippe Demers' *Inferno*. The analysis draws on neomaterialist perspectives – N. Katherine Hayles, Karen Barad, Jane Bennett, Timothy Morton, and Anna Tsing – to sustain a framework capable of addressing more-than-human meaning-making. A neomaterialist perspective on intermediality moves semiotics from a study of 'what things mean' to a study of 'what things do' within a shared material world.

**Keywords:** AI, environmental art, intermediality, multimedia, neomaterialism, semiotics

## 1. Introduction

In recent decades, the proliferation of digital technologies, artificial intelligence (AI), and robotics has given rise to new forms of cultural expression that challenge the categories through which media have traditionally been understood.

Environmental art, in particular, has absorbed these technological innovations to create installations that combine sound, image, algorithmic processing, and interactive participation. Some of these works compel audiences to reconsider the relationship between humans and their more-than-human environments, refining our conceptual vocabularies for describing how different media interact, overlap, and generate meaning. Two terms are especially pertinent here: intermediality and multimedia. Although often used interchangeably in colloquial contexts, they differ significantly in their historical development, theoretical underpinnings, and critical implications.

Multimedia is generally understood as the technical integration of various media formats – text, sound, image, animation, video, and so on – within a single environment. Its emphasis lies on functionality and user experience, particularly in digital convergence, where interactivity and immersion dominate design logics [1]. A multimedia installation or platform combines heterogeneous elements to achieve a communicative or aesthetic goal, often privileging the seamless coexistence of modalities. The concept is related to developments in information technology and computer engineering, foregrounding questions of design, delivery, and efficiency [2], sometimes involving remediation, that is, the process by which new media forms represent and refashion older media, creating a cultural dialogue that defines new media in relation to what came before [3].

In contrast, intermediality is a theoretical framework that originates in the field of media studies. Rather than focusing on the technical integration of media, it interrogates the relations, transformations, and hybridisations between them. Intermediality is less about coexistence and more about mutual interference, whereby one medium references, absorbs, or reshapes another [4]. It stresses the semiotic and aesthetic dimensions of these encounters: how meaning is produced when media cross boundaries, contaminate each other, or generate novel in-between forms [5]. As such, intermediality can be applied across historical periods – illuminated manuscripts, opera, Wagner’s concept of *Gesamtkunstwerk* and its contemporary implications [6], cinema [7], and digital environments [8] – whereas multimedia is more narrowly tied to contemporary technological affordances [9].

In the context of environmental art, these distinctions matter. Multimedia installations that employ AI or robotics typically foreground the integration of sensory modes: for example, spatialised soundscapes, algorithmically generated visuals, and immersive architecture. Yet when analysed through the lens of intermedial semiotics, these works can be understood not merely as technical amalgamations but as processes of mediation in which meaning arises through the tension and translation between media forms [10]. An AI system that transforms bio-acoustic data into generative visuals is not simply a multimedia device; it is also an intermedial phenomenon, reconfiguring the semiotic relationship between sound and image, nature and technology, data and perception.

This chapter situates itself within this conceptual nexus to explore how digital and AI-driven environmental art redefines the semiotics of mediation in the Anthropocene. Case studies include *The Great Animal Orchestra*, Andrea Polli’s climate-based works like *Heat and the Heartbeat of the City*, the collaborative project *Oceans in Transformation*, as well as BioArt such as Eduardo Kac’s *Genesis* and Anicka Yi’s *In Love with the World*, and finally *Inferno* by Bill Vorn and Louis-Philippe Demers. Through these studies, the chapter develops the concept of multimedia

intermedial ecologies to capture how these installations move beyond representation to perform ecological processes semiotically and materially, redistributing agency across human, nonhuman, and machine actors.

Moreover, the research argues that these works embody a neomaterialist sensibility, in which media are not passive carriers of content but active, agentic participants in ecological processes of signification [11]. By distinguishing intermediality from multimedia, the analysis highlights how AI-driven installations expand our understanding of environmental art: they are not merely multisensory spectacles but operative ecologies where semiotic and material agencies converge [12], mediating the more-than-human world [13].

## **2. Theoretical framework: Semiotics, intermediality, multimedia**

The study of intermediality is deeply entwined with questions of representation, materiality, and meaning-making, all of which are central to semiotic analysis. Semiotics, broadly defined as the study of signs and sign processes, provides analytical tools for examining how media convey meaning across modalities. When applied to intermedial studies, semiotics enables us to investigate how signs migrate from one medium to another, how codes are transformed through intermedial reference, and how new hybrid forms emerge through media interaction. To give an example, when we use a GPS, the ‘sign’ of our location is not just the dot on the screen; it is the mathematical negotiation between satellites, atmospheric conditions affecting signal speed, and our movement. Meaning is a real-time intermedial performance.

### **2.1 Intermediality: Historical and conceptual dimensions**

Irina Rajewsky [14] had distinguished between media combination (e.g., opera), media transposition (e.g., adaptation of a novel into film), and intermedial reference (e.g., ekphrastic poetry), all of which foreground the relational and processual nature of intermedial phenomena. Lars Elleström, in turn, elaborated on the notion of media modalities – material, sensorial, semiotic, and spatiotemporal – that enable a systematic analysis of how media intersect and transform one another [15]. These frameworks are invaluable for understanding how artistic forms, whether analogue or digital, engage in a dialogue that extends beyond representational surfaces into the material affordances of media themselves.

From a semiotic perspective, intermediality can be seen as a form of semiosis in motion, in which the signifiers of one medium are re-coded through the material and perceptual logics of another. This dynamic process highlights the fact that meaning is never contained within a single medium but is constantly negotiated in the space ‘in between’. In this sense, intermediality challenges the fixity of medium-specific categories, revealing a fluid field of aesthetic and cultural exchanges instead.

### **2.2 Multimedia: Technological integration and design logics**

In contrast, multimedia refers to the technical and functional integration of several media formats – text, sound, image, video, animation, interactivity – within

a single product or platform. Its emphasis lies less on semiotic transformation and more on the transfer of multisensory content to users. The rise of personal computers, CD-ROMs, and later the internet in the 1990s marked the consolidation of multimedia as a key concept in information technology and design. Today, immersive environments such as virtual reality (VR) and augmented reality (AR) exemplify multimedia in practice: they orchestrate multiple modalities to enhance user engagement, often with a focus on seamless interaction.

As aforementioned, while intermediality is primarily an analytical concept, multimedia is rooted in practical and technological contexts. The distinction is, therefore, not merely semantic: intermediality seeks to interpret the meaning-making potential of media encounters, while multimedia tends to describe their functional assemblage. Nonetheless, there are points of convergence. Multimedia environments can be analysed intermedially, especially when the interplay of media exceeds technical aggregation and produces aesthetic or semiotic transformations [16].

### **2.3 Intermedial semiotics in the digital age**

AI and digital computation introduce new complexities into this landscape. Generative AI (GenAI) that generates images from text (tools such as DALL·E, Midjourney, or Stable Diffusion) constitute more than multimedia systems: they enact intermedial transpositions, translating linguistic prompts into visual form through more-than-human semiosis. Similarly, immersive installations that use real-time data streams, whether from environmental sensors, biofeedback, or audience participation, perform intermedial operations in which signs circulate dynamically across sensory and material registers [17].

From a semiotic standpoint, these AI-driven environments expand the scope of intermediality by decentring human intentionality. Meaning arises from pattern recognition, algorithmic recombination, and the material affordances of the media infrastructures themselves, all of which enable human interpretation. In this sense, contemporary multimedia art installations, particularly those engaging with AI, should not be reduced to their technical integration of formats. Instead, they demand an intermedial semiotics attentive to the distributed agencies – human and nonhuman – that co-produce cultural experience [18].

Thus, intermediality and multimedia, though conceptually distinct, are increasingly entangled in the digital age. Environmental art provides a crucial site where these entanglements can be examined: installations that combine bioacoustics, generative visuals, robotic interfaces, and audience interaction not only highlight multimedia orchestration but also embody intermedial processes of mediation, media translation, and transformation.

### **2.4 Rethinking the ‘medium’ from Peircean semiotics to posthumanist and new materialist aesthetics**

In the era of ubiquitous digitalisation and AI, the concept of ‘medium’ has acquired unprecedented theoretical density. It is no longer sufficient to consider it merely as a channel between a sender and a receiver, or even as a neutral technical device that conveys information. More and more, the medium is emerging as an ontologically complex entity capable of shaping experience, configuring forms of

agency, and producing meaning within dynamic networks of relations [19]. In this conceptual transformation, intermedial semiotics provides a fertile framework for analysing the proliferation and reconfiguration of media, particularly in digital art and cultural practices mediated by intelligent technologies. This perspective draws on a philosophical and semiotic tradition that can be traced back to Charles Sanders Peirce, whose triadic notion of the sign (CP 2.228, 1897) [20] constitutes one of the pillars for understanding the relational and generative character of the medium.

Unlike the Saussurean tradition, which privileged the opposition between signifier (the physical form – a word or sound – that produces the linguistic ‘sign’) and signified (the mental concept or meaning that a person associates with a sign), Peircean semiotics invites us to understand mediation not as mere representation, but as an act of production. For Peirce, the relation among Object (the actual thing or concept to which a sign refers), the Representamen (the sign in its perceptible form), and the Interpretant (the mental concept or meaning created in the mind of the interpreter – human or other – as a result of the sign) constitutes an open and continually updating meaning-making process that generates chains of ‘unlimited semiosis’ (CP 5.484, 1907) [20]. The Representamen is not a passive reflection of the Object but an instance that actively ‘mediates’ it. It is a ‘medium’, in Peirce’s sense, constitutive of the process of meaning-making. He describes it as a substrate capable of habit-taking and as a ‘Third’ that communicates a Form (CP 2.228, 1897) [20]. Likewise, the Interpretant is not a fixed or closed entity but a contextual update involving minds (human and other than human) and diverse materialities. As Peirce explains, ‘thought is not necessarily connected with a brain’ (CP 4.551, 1906) [20], and may be instantiated in any medium capable of taking habits. His ‘inkstand’ analogy in his manuscript ‘On Pragmatism’ (later in volume 7 of his *Collected Papers*) further illustrates this distributed cognition.

*A psychologist cuts out a lobe of my brain and then, when I find I cannot express myself, he says, ‘You see, your faculty of language was localized in that lobe’. No doubt it was; and so, if he had filched my inkstand, I should not have been able to continue my discussion until I had got another. Yea, the very thoughts would not come to me. So, my faculty of discussion is equally localized in my inkstand.*  
(CP 7.366, 1907) [20].

Within Peirce’s framework, the medium ceases to be a container or channel and becomes a performative operation. Its specific materiality – whether linguistic, visual, sonic, digital, or hybrid – actively participates in the configuration of meaning. This conception allows us to understand the sign as a dynamic and continuous interpretive intermedial process, in which each sign generates new signs in an infinite semiotic chain.

By adopting a relational ontology, Peircean semiotics opens the possibility of thinking of the medium as something that emerges in interaction and is not predetermined but updated in each instance of semiosis. This notion displaces the primacy of the autonomous, rational human subject as the sole producer of meaning, recognising distributed agency among bodies, technologies, environments, and materialities [18].

In the field of art, digital interactive installations and AI-generated artworks exemplify this trend. In them, the medium is no longer a passive support but an active agent that reconfigures the relationship between creator, spectator, and

artwork. Large Language Models (LLMs) and other AI systems are not merely tools; they function as semiotic agents whose outputs are interpretive acts in a broader, complex ecosystem. Intermedial semiotics highlights how AI outputs invite, rather than dictate, meaning, requiring contextual negotiation and critical reflection from humans and machines together. By shifting the focus to these entangled, material, and distributed processes, neomaterialist-informed intermedial semiotics creates a more robust, ecologically aware framework for understanding how meaning is created in a complex posthuman world [18].

## **2.5 From expanded sign to distributed agency: Convergences with posthumanism and new materialism**

Building on Peircean foundations, contemporary intermedial studies emphasise the procedural and relational nature of the medium [19]. Every medium is intermedial in potential, as its function depends on its interaction with other media systems. In this perspective, intermediality is not limited to works combining different media; it refers to an aesthetic and cognitive regime where meaning is generated in the friction and convergence of different coding modes. This is particularly evident in digital and hybrid artistic practices, where code, interface, user body, and data architecture simultaneously participate in the aesthetic experience. Authorship is distributed between humans, machines, and algorithms, materiality unfolding between the physical and virtual, with temporality reconfigured through real-time updating processes. These practices problematise the boundaries of the notion of medium and reveal its active, unstable, and emergent character – something that aligns with neomaterialist approaches that have gained prominence in contemporary philosophy.

Thinkers such as Donna Haraway, N. Katherine Hayles, Karen Barad, Jane Bennett, or Timothy Morton, among others, have questioned the centrality of the modern human subject, proposing models of distributed agency where the human, the nonhuman, the material, and the semiotic co-constitute the conditions of existence and meaning-making. While Haraway speaks of forms of symbiosis (2008, 31) [21], Barad's theory of 'agential realism' emphasises that entities do not pre-exist their relations but emerge through intra-actions, processes in which meaning and matter are co-constituted agents [12]. She also highlights the importance of materiality, understood as a productive force actively participating in processes of meaning-making.

Examples of this are interactive installations that respond to viewers' bodies, generative artworks that transform over time, or ecological data visualisations that link the natural and the digital. In all cases, the notion of the medium as a mere vehicle is surpassed by a vision in which media act, feel, affect, and transform. Environmental multimedia installations embody this principle, going beyond representations of ecological processes and becoming sites where technology, environment, and perception 'intra-act', in Barad's terms [12], to produce new semiotic realities. In these contexts, intermediality describes not only the translation between media forms but also the entanglement of agencies that shape the field of signification.

Jane Bennett's concept of 'vibrant matter' also highlights the vitality of nonhuman agencies, reminding us that materials – from bioacoustic recordings to electrical circuits – actively participate in meaning-making [22]. This insight is

crucial for understanding AI-driven multimedia ecologies, where cables, sensors, algorithms, and living organisms coalesce into assemblages of signification. The intermedial interplay of sound, image, and data does not merely rely on human interpretive frameworks; it is materially enacted by the agencies of the media themselves.

N. Katherine Hayles [23] characterises the ‘cognitive nonconscious’ as the entanglement of human thought with algorithmic, non-conscious processes that subtly shape meaning. Her work demonstrates that cognition is never an isolated activity; it is always interwoven with the tools and artefacts through which it unfolds, especially within digital environments. Far from being neutral, computational systems structure and organise the immense flows of data we encounter daily, participating in cognitive activity by orienting perception, influencing decisions, and even generating creative outcomes. These invisible operations complicate traditional notions of agency and authorship, raising pressing questions about autonomy (such as those underpinning the circulation of misinformation) in an age where technological processes actively redefine what it means to think, create, and interpret.

These perspectives shift attention to how signs are processed, transformed, and enacted across different substrates of materiality and perception. As seen in the following lines, in installations such as *The Great Animal Orchestra*, machine learning algorithms and human listeners function as interpretants in Peircean terms, producing a multi-sited semiosis that cannot be reduced to a single locus of agency.

Additionally, Timothy Morton’s notion of ‘hyperobjects’ – entities so massively distributed in time and space that they exceed human perceptual scales – further highlights the stakes of environmental intermediality [24]. Climate change, biodiversity loss, changing ocean currents, and ocean acidification are environmental hyperobjects that can only be approached through mediation. Additionally, human-made hyperobjects such as radioactive waste, plastic, oil spills, or Styrofoam are among the materials created by humans that will exist for thousands of years, far outlasting human civilisation. AI-driven multimedia installations function as semiotic strategies for engaging with these vast phenomena, translating their scales, imperceptible to human perception, into experiential forms. Here, intermediality allows signs to circulate across modalities in ways that render hyperobjects perceptible, even if they can never be fully grasped, raising awareness of the impact of pollutants.

Finally, Anna Tsing’s reflections in *The Mushroom at the End of the World* add another layer to this constellation of thought by foregrounding the art of ‘noticing’ [25]. Tsing argues that life, hope, and collaborative survival are possible within the capitalist ruins of ecological destruction. Her idea that no species survives alone is exemplified by the matsutake mushroom. Because these mushrooms require complex relationships with specific trees and soils and cannot be farmed in a factory, they are inherently non-scalable, representing a form of survival that defies the rules of industrial efficiency. This delicate balance relies on a reciprocal assemblage where the mushroom needs the pine tree, the tree needs the mushroom, and the forest often requires human disturbance to the soil to thrive. Ultimately, these species are deeply entangled in webs of dependency and collaborative connections [26].

Intermedial semiotics contributes to expanding neomaterialist perspectives, considering, for instance, how raw, pre-linguistic, and sub-cognitive stimuli – such as light frequencies, haptic vibrations, and sound waves – bypass cognitive decoding

to produce meaning directly through the body. Meaning is not just a mental concept; it is an affective state – a feeling of pleasure, discomfort, or urgency. This shifts the focus to how sonic ambiance or haptic sensations are felt, shaping spatial orientation and emotional states. This perspective moves beyond traditional interpretative semiotics, focusing instead on how embodied or ‘affective’ experiences – felt sensations, visceral reactions, and proprioceptive inputs – intervene directly in meaning-making. It also acknowledges the communicative potential of all living and non-living things (e.g., fungi, lichen, weather systems, as well as the agency of machines), turning intermedial semiotics into a wide field for studying human and more-than-human interactions [26].

This approach suggests that a sign is not just something to be understood, but something that physically alters physical states as well as environments. Interactions can be broadened to include ‘noticing’. That is, rather than interpreting a sign, this approach focuses on proto-semiotic processes. For instance, a sudden loud sound (sound wave) or a sharp, unexpected vibration (haptic feedback) triggers an automatic bodily response before the mind can process it. Intermedial semiotics analyses how these bodily sensations are integrated with, or act as, mediums themselves. Technological examples include haptic gloves and other enhancements that can help create full bodily immersion by manipulating senses beyond just the visual or auditory. Additionally, this expanded view of intermedial semiotics includes the sub-perceptual, considering how natural, environmental, digital, and AI systems communicate through material modalities, challenging the purely anthropocentric focus on language.

Indeed, from the perspective of intermedial semiotics, the different scales of symbiotic collaboration highlighted by neomaterialist approaches can be translated into sensory forms by means of AI technologies, cultivating modes of ‘noticing’ that include embodied and relational practices that help audience awareness and engagement with ecological transformations [26]. When applied to environmental multimedia ecologies, intermedial semiotics enhances this art of ‘noticing’ by highlighting the tech-translations through which ecological processes become audible, visible, or tactile in AI-mediated environments.

Neomaterialist approaches, some of which have been previously mentioned, broaden traditional semiotic frameworks by suggesting that meaning is not solely a product of human consciousness or discourse, challenging the idea that humans are the only ones capable of creating meaning. Instead, they propose a posthuman [27] ecology of signs, where meaning is not created by a single subject but is a fluid, collaborative, and distributed process involving human, nonhuman, and material agents. Rather than viewing signs in isolation, this perspective treats them as part of a complex ecology or assemblage. Here, meaning is produced in a relational network, where natural elements (rocks, animals, ecosystems) and artificial elements (technology, data) actively shape the environment’s meaning.

In a posthuman ecology [27], the boundary between the inside (human thought) and the outside (the environment) dissolves. By integrating this approach with intermedial semiotics, which examines how media modalities (material, sensorial, spatiotemporal) [15] intersect, foregrounding that they are embedded within the physical environment, we move from treating signs merely as human-coded symbols to viewing them as material entanglements. Bennett’s concept of ‘vibrant matter’ [22], for instance, ascribes agency and vitality to nonhuman entities (machines, plants, microbes, environments), acknowledging them as active participants in

meaning-making. Matter has a 'thing-power' [22] that influences outcomes. Therefore, meaning is distributed across an entire assemblage, and it is co-produced or intra-acted [12] through the interaction of human bodies, nonhuman agents, and material forces.

As mentioned, this perspective treats nonhuman actors such as viruses, climate systems, or technologies – as agents that possess their own force, capable of making a difference in the world. Thus, rather than interpreting signs as fixed representations, this perspective sees them as emerging from the dynamic entanglements between an animated world of matter, where meaning is an active, ongoing, and fundamentally non-anthropocentric event [21].

When informed by these neomaterialist perspectives, intermedial semiotics breaks down the divide between human signs (language) and nonhuman signals (chemical, biological, environmental). Additionally, the distinction between natural and artificial is blurred, so that technological artefacts – from digital AI to environmental infrastructure – participate in creating 'techno-poetic consciousness' [28]. Meaning is not produced by a human using a machine, but rather through co-creation and distributed agency, where the AI/machine, the human, and the data environment co-generate the sign.

The above synthesis of neomaterialist insights, aligned with intermedial semiotics, fundamentally redefines meaning-making as a collective, material performance. Rather than viewing signs as static representations, this expanded framework treats them as dynamic assemblages where agency is shared between human perception, algorithmic processing, and environmental forces. In the context of AI-driven environmental art, the integration of multiple media does more than provide a technical stage; it creates a site of material 'intra-action' [12]. Here, signs emerge from the friction between data streams and physical landscapes, transforming ecological processes into felt, semiotic events. Ultimately, this posthuman ecology demands that the medium is no longer seen as a neutral vessel, but as a participant whose physical and technological properties actively negotiate our understanding of a world in flux.

### **3. Experimental framework: AI-driven projects for environmental ecologies**

The environmental crisis has increasingly found expression in contemporary art, which seeks to go beyond the representation of ecological concerns to intervene in the sensory and affective registers through which humans engage with the more-than-human world in order to raise not just awareness but also encourage problem-solving actions. Digital technologies, particularly AI and computational media, have become central to this endeavour. Their capacity to process, analyse, and transform vast amounts of environmental data has opened new possibilities for the creation of multimedia ecologies, in which sound, image, algorithm, and interaction converge to generate immersive aesthetic experiences that can drive audiences to react in the face of the environmental crisis. These works extend beyond traditional forms of environmental representation embodying operative processes that materialise the interconnections between human and more-than-human agencies.

Consider urban air-quality monitoring systems, that is, networks of sensors distributed across cities that continuously measure particulate matter, carbon

dioxide, nitrogen oxides, and other pollutants. These devices actively participate in shaping civic life. Their readings inform public health alerts, guide urban planning decisions, and even influence personal choices, such as when to exercise outdoors. In this sense, sensors and the atmospheric conditions they register become semiotic actors: they produce data that is translated into signs – maps, graphs, notifications – that shape human perception and behaviour. Such infrastructures exemplify how technological and ecological processes collaborate in everyday environments, redistributing agency beyond the human and embedding nonhuman actors into the fabric of decision-making.

In a similar way, numerous contemporary artistic projects harness these more-than-human agencies – whether sensor data, atmospheric processes, or bioacoustic signals – to raise ecological awareness, transforming the often-invisible dynamics of environmental change into experiential forms that audiences can perceive, interpret, and act upon.

A paradigmatic example is *The Great Animal Orchestra* (2016–ongoing), created by eco-acoustician Bernie Krause in collaboration with United Visual Artists (UVA) [29]. This immersive installation is based on Krause’s extensive archive of field recordings, or ‘bio-phonies’, spanning rainforest habitats, ocean ecosystems, and endangered species soundscapes, into a dynamic sonic and visual environment that documents the life of ecosystems across the globe. By synchronising Krause’s archive with real time, three-dimensional (3D) spectrograms (AI-driven spectral analysis) developed by UVA, these recordings are transformed into dynamic visual landscapes that accompany the sounds. Additionally, the inclusion of ‘geo-phonies’, non-biological natural sounds like wind, rain, and shifting earth, acts as a critical semiotic anchor that decentralises the human subject. Within this posthuman ecology, ‘geo-phonies’ are not merely background noise; they represent the primordial, 4.5-billion-year-old palette that establishes the physical bandwidth for all subsequent life to evolve. By transposing these ancient vibrations into light particles and 3D spectrograms, the installation forces a recognition that meaning-making began long before human language. The environment itself becomes a vibrant participant that dictates the orchestral structure, where animal bio-phonies must find their niche within the geophonic constraints.

The installation includes 3D visualisations of sound frequencies, real-time sound and immersive audio, large-scale projections, interactive sensors, as well as AI-driven mechanisms, all directed to analyse biodiversity through sound. Thus, it exemplifies an intermedial ecology in which multiple formats (sound, data, algorithm, architecture, and projected light) translate and reshape one another, allowing audiences to visualise the acoustic niches of healthy ecosystems and, more critically, the haunting silence displayed in degraded ones, making the abstract loss of biodiversity a physically felt reality. The visualisation of ‘anthropophony’ (or anthropophony, that is, human-generated sound) serves as a stark semiotic marker of ecological trauma, transforming abstract environmental decline into a visible hush or dimming of the natural world. In this way, the project reveals how human activities (urbanisation, industrial logging, coral-reef destruction, global warming, etc.) act as disruptive forces that fragment the acoustic niches of healthy habitats.

One of the pillars of soundscape ecology, ‘anthropophony’, is shown to submerge the ‘animal orchestra’ or render it entirely silent, signifying a breakdown in the harmonious sonic evolution that has occurred over millions of years. This shift communicates that biodiversity loss is not just a physical absence of creatures but

also a collapse of the complex semiotic relationships they share. Thus, the project creates an intense sensorial and affective experience that drives the audience to stop interpreting nature from a distance and instead interact with a world where humans are often the disruptive forces.

Other environmental installations confirm this urgent plea for environmental preservation. Andrea Polli's *Heat and the Heartbeat of the City*, for example, used climate data to produce a real-time audiovisual representation of urban air quality [30]. Conducted between 2004 and 2006 in New York City, the project used NASA scientific measurements of climate data, including air quality, temperature, and atmospheric conditions, to generate sound and visual patterns that reflected the city's environmental rhythms — an audible 'heartbeat' that accelerated with rising temperatures, bridging abstract environmental data with human physiological experience. By transforming abstract data into sensory form, Polli created an intermedial installation that allowed audiences to perceive urban climate processes as lived, embodied experiences, highlighting the entanglement of scientific observation, algorithmic mediation, and aesthetic interpretation in environmental awareness.

In *Oceans in Transformation* (2020), the neomaterialist expansion of semiotics reaches a planetary scale [31]. This large-scale collaborative research and exhibition project foregrounds the ocean as a central site for understanding the Anthropocene. Conceived by Territorial Agency, in partnership with TBA21-Academy and e-flux Architecture, the project departs from the observation that human impact on Earth is often narrated in terrestrial and atmospheric terms – through stratigraphic layers, landscapes, or climate markers. The ocean, which covers more than 70 percent of the planet, becomes the focus, for it remains an under-theorised yet critical domain. The project employs satellite and oceanographic data to construct a multimedia visualisation of planetary change.

This work exemplifies an ecology of signs and hyperobjects [24] by synthesising massive datasets – ranging from satellite bathymetry and sea level rise to the movement of microplastics and industrial fishing fleets – into a dynamic, sensory architecture. Within this intermedial framework, the ocean is treated as a vibrant participant that actively writes its own history through shifting currents, thermal expansion, and chemical changes. Thus, the project translates the material traces of less perceptible processes of marine degradation, such as acidification, deoxygenation, the flow of pollutants, or the impact of deep-sea mining and biodiversity loss, into a visual language of interconnected lines and pulses that humans can see, suggesting that the ocean itself is a semiotic agent communicating its stresses in legible forms. This creates a trans-semiotic experience where the viewer perceives the ocean as a living assemblage, where meaning is not found in a single data point but in the intermedial interplay between the slow time of geological change and the rapid-fire data of modern industry. Numerical data become interpretative visual patterns. Remote sensing and oceanic processes develop into semiotic events. In this way, a change in water temperature comes to be more than just a number and can be interpreted as a sign of the disruption in the planetary heartbeat. Ultimately, *Oceans in Transformation* suggests that understanding the climate crisis requires an expanded semiotic framework capable of reading the signs produced by nonhuman environments. It moves the audience from being mere observers to being part of a distributed cognition [11], where meaning is co-produced by the interaction of the sea, the sensing machine, and the human witness.

BioArt provides another crucial dimension to this landscape, as it often incorporates living systems into artistic practice. The SymbioticA laboratory in Perth has pioneered such approaches, producing installations in which biological processes themselves become media. Although not focused explicitly on environmental issues, works of this kind open critical avenues for rethinking the semiotic interplay between biological and technological media. They reveal how living matter can itself function as a sign system, one that intermedial semiotics must account for alongside traditional and digital forms. For example, in *Victimless Leather* (2004), Oron Catts and Ionat Zurr extend the semiotic inquiry from the digital translation of code to the material agency of the living fragment. By culturing immortalised mouse and human bone cells upon a biodegradable polymer scaffold, which they term a 'bioreactor', the artists create a semi-living entity: a miniature synthetic jacket. Within a neomaterialist framework, this work collapses the ontological distance between the natural body and the industrial product. The jacket becomes a participant within a techno-scientific infrastructure that functions as its artificial body. Here, the boundary between biological cognition (the cellular response to the nutrient media) and the technical substratum dissolves. The medium (bioreactor) is an active component in the assemblage. This was shown during its exhibition at MoMA, where the cells grew so vigorously that they clogged their own life-support tubes, forcing euthanasia on the work. The growth and eventual death of cell expansion forced the audience to confront the ethical and semiotic status of life that is neither fully natural nor purely artificial. The monstrous growth of the medium itself became a new semiotic event: a sign that emerges from the agency of the matter, challenging the human desire for total technological control and highlighting the messy, uncontrollable vitality that characterises our shared existence [32].

In Andrea Polli's *Heat and the Heartbeat of the City*, the city's temperature data ceases to be an abstract statistic and becomes a rhythmic, sonified pulse – a material sign of a feverish urban body that echoes the metabolic struggles of Catts and Zurr's semi-living cells. This biological resonance is further amplified in *The Great Animal Orchestra*, where the acoustic niches of the natural world are revealed as a complex, self-organising language. Here, the silence caused by human disruption is not merely an absence of sound, but a material glitch in the planetary assemblage, much like the clogged tubes of the *Victimless Leather* jacket. Finally, *Oceans in Transformation* scales this semiotic inquiry, mapping the signs of rising tides and shifting currents as the ocean's sensing body and its own reactive agency that communicates its own dynamics.

Eduardo Kac's *Genesis* (1998–99) was a landmark transgenic artwork that integrated biology, language, digital systems, and human participation into a single ecological network of meaning [33]. Here translation was operationalised as a performative act of production that bridged the divide between symbolic code and biological materiality. By translating a biblical verse asserting human dominion into Morse code and then into a synthetic DNA sequence, Kac treated the genomic substrate as an active agent in an infinite semiotic chain. When incorporated into *Escherichia coli* bacteria on a petri dish placed within an ultraviolet (UV) light box in the gallery, connected to a web server triggered by remote participants, the DNA underwent physical mutations that rewrote the original text. A flexible micro-video camera and microscope illuminator were focused on the petri dish. A larger-than-life, live video of the bacterial division and interaction was projected

onto the gallery walls and streamed over the internet, making the microscopic semiotic events visible to the audience. Visitors, both in the gallery and online, were able to activate UV radiation, accelerating mutation and altering the genetic code. The organisms' fluorescent proteins made these changes visible in shifting colours, while video projection, textual displays, and algorithmically generated sound expanded the event into a multisensory installation.

*Genesis* thus staged a dialogical interaction between biology, technology, ethics, and belief systems, where the encoded biblical sentence gradually evolved into new, unintended forms. The work exemplifies multimedia intermedial ecologies: multimedia because it orchestrates text, image, sound, data, and living matter; intermedial because each medium transforms the other; biological processes become textual mutations, algorithms translate into music, and light alters genetic code. This process illustrates how meaning is a continually updating negotiation between human intent, digital interfaces, and the biological affordances of the medium. The final, altered text served as a semiotic record of transgenic communication, highlighting that creativity was an emergent property of a system where biological and computational logics merged into a single, continuous flow of signs.

Viewed through a Peircean lens, DNA, the bacteria, and the UV light functioned as semiotic agents whose biological interpretive acts physically altered signs and generated new interpretants, collapsing the ontological divide between the language and the material substrate. Thus, *Genesis* became a site of distributed cognition, with agency localised neither in the artist nor the bacteria, but emerging from the circulation of signs across heterogeneous substrates. The petri dish became the modern equivalent of Peirce's 'inkstand' (CP 7.366, 1902) [20], a material substrate constitutive of the meaning-making processes, where biological processes and human-triggered digital inputs merge to rewrite the original text. Ultimately, *Genesis* demonstrates that the medium is a 'Third' that communicates a Form (CP 2.228, 1897) [20] through its own specific materiality. By allowing the biological constraints of the bacteria to dictate the final linguistic output, Kac displaces the primacy of the autonomous human subject. The resulting mutated text is a contextual update, a new sign in an ongoing chain that highlights how agency is shared among bodies, technologies, and environments in a complex more-than-human world.

In Anicka Yi's *In Love with the World* [34], the posthuman ecology of signs expands from the laboratory petri dish to the monumental scale of the Tate Modern's Turbine Hall, where the distinction between biological, technological, and environmental agency is further dissolved. Yi populates the space with large, floating, balloon-like 'aerobes', that is, autonomous, helium-filled, mushroom-like machines that, inspired by ocean life, navigate the hall using AI-driven sensors to detect heat from human visitors. The aerobes are semi-autonomous organisms that function as semiotic agents whose behaviours, ranging from curiosity to shyness, constitute real-time interpretive acts. Drifting through the vast industrial space and responding to environmental cues as well as the presence of human visitors, the installation operates as an open, continually updating meaning-making process, where the air itself, scented with diverse odours, becomes a constitutive medium for intermedia negotiation.

Yi's installation was not overtly framed as environmental criticism, yet it enacted a more-than-human ecology in which nonhuman agents shaped the conditions of perception and meaning. The aerobes invited viewers to imagine unfamiliar forms of

life and cohabitation, raising questions about symbiosis, adaptation, and the limits of anthropocentric thinking. As a multimedia intermedial ecology, the work orchestrated multiple modalities: sculptural form, algorithmic control, spatial choreography, and embodied audience experience. At the same time, it exemplified intermediality by allowing biological metaphors, robotic agency, and sensory immersion to transform one another. In doing so, Yi's project foregrounded the semiotic and ecological agency of entities beyond the human.

Finally, in Bill Vorn and Louis-Philippe Demers' *Inferno* (2015–ongoing) [35], a robotic performance installation, the posthuman ecology of signs is manifested through a sort of choreography that reconfigures the human body as a medium for machine expression. Participants are fitted with tele-operated, upper-body exoskeletons that coerce their movements, responding to centralised algorithms and synchronised control systems. This installation displaces the primacy of the autonomous human subject by subordinating individual agency to a robotic entity. The human body becomes a medium among others, enmeshed within a multimedia assemblage that includes kinetic motion, sound, light, and machine control. The participants' physical autonomy is shared, in varying degrees, with pre-programmed or algorithmically responsive systems. This creates a hybrid field of agency, with humans and machines becoming kinetic co-performers. In this way, the installation dislocates semiotic intentionality and distributes agency across human and more-than-human elements, illustrating a world where creation is an emergent property of entangled materialities.

Together, these works suggest that whether at the level of a cellular fragment, a city's climate, or a global ocean, semiosis is an emergent property of a posthuman ecosystem. Meaning is not something humans impose upon a passive world; it is a co-production where the biological, the technical, and the environmental inter- and intra-act [12]. This shifted perspective demands a new intermedial literacy; one that recognises the habit-taking (CP 4.551, 1906) [20] processes of matter itself as we navigate the unpredictable negotiations of a changing planet.

In all the examples briefly explored, multimedia functions as the technical condition of possibility, providing the platform for the integration of diverse media modalities, while intermediality serves as the interpretive lens that reveals the transformations of signs across media. The ecological significance of these works emerges precisely in this interplay: they not only communicate environmental crisis; they also enact it materially and semiotically, compelling audiences to experience ecological change through multisensory immersion. In Krause's archive, the migration of sound into image is not merely a matter of format integration but a semiotic event that foregrounds silence as a sign. In Polli's work, climate data becomes audible and visible, not through mere multimedia presentation but through intermedial processes that translate scientific codes into sensory perception and semiotic interpretation. Kac and Yi both merge biological and computational logic into a single semiotic continuum where the thought processes of the artworks are instantiated in their intermedial interactions, sites of mutual transformation between humans and more-than-humans. Such entanglements reach a peak in Vorn and Demers' project, where the human body is reconfigured as a material substrate for machine expression.

Ultimately, the concept of intermedial semiotic ecology, as presented in these projects, serves to stress that semiosis is not a top-down human imposition but an emergent property of intra-acting materialities. It highlights that environmental and technological media are not neutral carriers but vibrant participants in an infinite

semiotic chain that demands a more complex and ecologically aware understanding of how meaning is co-produced.

The works explored demonstrate that AI-driven and data-based environmental art should be read as multimedia intermedial ecologies, in which ecological processes are mediated through a complex interplay of technological and semiotic agencies. The convergence of bioacoustics, data visualisation, robotic movement, and living matter illustrates how environmental art in the digital age mediates the more-than-human by creating immersive semiotic environments that redistribute agency across humans, machines, and ecosystems.

#### **4. New frontiers for intermedial environmental research: The implications of AI-driven projects**

The preceding examples show how digital and AI-driven environmental installations operate as multimedia intermedial ecologies, where technical integration (multimedia) and semiotic transformation and interpretation (intermediality) converge to mediate more-than-human processes. These works foreground the entanglement of ecological, technological, and cultural systems, thereby reconfiguring how meaning is produced and experienced in the Anthropocene.

One of the central implications of this convergence is that the medium ceases to be a mere container or channel and becomes a sign in itself, able to generate further semiotic operations [36]. Traditional environmental art often sought to represent landscapes or species symbolically, using painting, photography, or film to evoke ecological awareness. By contrast, contemporary AI-based installations enact ecological processes semiotically and materially. *The Great Animal Orchestra*, for example, does not simply illustrate biodiversity loss; it performs it through silence and absence, enabling audiences to experience the ecological crisis as an imminent cataclysm. However, this operational turn also raises critical ethical questions. As Sean Cubitt has argued, digital technologies have profound ecological costs, from rare earth extraction to energy consumption [37]. AI-driven environmental art is not immune to these issues: the infrastructures that enable immersive mediation may themselves contribute to the crises that they seek to address. Intermedial semiotics thus calls for a reflexive awareness of how the materiality of media participates in environmental assemblages. Art that claims to reveal ecological processes cannot be divorced from the ecological footprint of its own media technologies.

A second implication concerns the redistribution of agency. In intermedial ecologies, agency is not confined to human creators or viewers but distributed across machines, environments, and nonhuman organisms. Works like Polli's *Heat and the Heartbeat of the City* foreground how sensors and data streams actively shape aesthetic experience. Kac's *Genesis* foregrounds the translation of language into genetic code to expose the fragility of human claims to mastery over nature, as well as the interplay between belief, biology, and computation. Yi's *In Love with the World* imagines speculative life-forms that blur the boundary between organic and artificial existence. *Oceans in Transformation* works at the planetary scale, transforming remote-sensing data into aesthetic forms that render the impact of 'hyperobjects' [24] perceptible. Taken together, these works demonstrate how multimedia intermedial ecologies can operate both at the molecular level of biological processes

and at the spatial level of immersive environments, redistributing agency across diverse human, nonhuman, and technological actors, cultivating new modes of ecological awareness. From a philosophical standpoint, they challenge anthropocentric assumptions, suggesting a more expansive semiotics that includes more-than-human interpretants in meaning-making processes, as claimed by posthumanist and neomaterialist approaches.

Third, these installations shed light on the temporal and scalar dimensions of the ecological crisis. As Morton has noted, hyperobjects – plastics and microplastics, oil spills, radioactive waste, climate change, or extinction, among others – are often man-made or, in some cases, natural and nonlocal, as they are not confined to one place. They are massively distributed in time and space, far beyond human comprehension, and cannot be perceived directly [24]. Only through intermedial mediation do they become partially perceptible. The translation of data into audio-visual forms provides an experiential grasp of phenomena that otherwise exceed human perception. Here, intermedial semiotics demonstrates how mediation creates conditions for engaging with entities that elude direct experience.

Finally, AI-driven environmental art poses the risk of aesthetic instrumentalisation. Multimedia environments can seduce audiences with spectacular forms of immersion that risk reducing ecological processes to consumable experiences. The task of intermedial semiotics is to discern when such works critically engage with ecological mediation and when they merely aestheticise environmental data. The difference lies in whether intermedial transformations generate new modes of awareness and responsibility or merely reinforce spectacle.

Taken together, these considerations suggest that intermedial semiotics offers not only an interpretive lens but also a critical framework for evaluating the ethical and aesthetic stakes of environmental multimedia. By foregrounding processes of remediation, translation, transformation, and mediation, it highlights the ways in which AI-driven art can both expand and complicate human modes of ecological engagement. At stake is not only how we represent the environment but also how we learn to think, feel, and act within intermedial ecologies that already entangle the human and the more-than-human.

## 5. Conclusions

This chapter has argued that digital and AI-driven environmental installations exemplify what can be described as multimedia intermedial ecologies, environments where technological integration and semiotic transformation converge to mediate more-than-human processes. By distinguishing multimedia as the technical orchestration of modalities from intermediality as the semiotic interplay and transformation between them, the paper has shown how contemporary environmental art extends beyond multisensory integration to generate dynamic processes of meaning.

The case studies examined – including *The Great Animal Orchestra*, Andrea Polli's climate-based installations, the collaborative *Oceans in Transformation*, BioArt from Eduardo Kac and Anicka Yi, or Bill Vorn and Louis-Philippe Demers's *Inferno* – demonstrate how deeper ecological awareness can be stimulated by translating natural processes beyond the grasp of human perception into intermedial systems that can be seen, read, and interpreted. Silence, absence, or microbial rhythms

acquire semiotic force through their transformation across media modalities, drawing attention and helping humans notice the multiple languages of natural phenomena [26]. They remind us that meaning is not confined to human symbols but distributed in diverse sign systems across material agencies that can be both natural (biological) and artificial (mediated by tools and machines). They also reveal how meaning is produced through the entanglement of distributed agencies that operate across different scales of life [24], from the molecular to the planetary [12].

The theoretical perspectives of Hayles, Barad, Bennett, Morton, and Tsing, among others, provide a foundation for expanding intermedial semiotics into posthuman and neomaterialist frameworks. This expanded lens highlights three key contributions of AI-driven environmental art. First, it shifts from representation to operation, enacting ecological processes rather than depicting them. Second, it redistributes agency, foregrounding the roles of machines, environments, and organisms, alongside humans, as interpretants within semiotic systems. Third, it engages with temporal and scalar phenomena that elude direct perception but become partially graspable through aesthetic mediated forms, hence the crucial role of the arts in shaping media dynamics [36].

At the same time, the discussion presented in this chapter has highlighted the ethical and environmental ambiguities of such practices [37]. The infrastructures that enable multimedia immersion are themselves embedded in ecological costs, from material extraction to energy consumption. Moreover, the spectacular affordances of multimedia risk reducing ecological crises to aestheticised experiences. Intermedial semiotics, therefore, functions not only as an interpretive framework but also as a critical tool for discerning when artistic mediation generates new forms of ecological awareness and responsibility.

Ultimately, the concept of multimedia intermedial ecologies shows the need for thinking across technical, semiotic, and ecological registers. AI-driven environmental art reveals that mediation is not a neutral process but an operative ecology in which humans, machines, and more-than-human worlds are entangled. By analysing these processes through intermedial semiotics, scholars can better understand how meaning, matter, and agency converge in contemporary cultural practices, thus providing the foundation for a broader discussion of the ethical, aesthetic, and epistemological stakes of intermedial semiotics in the Anthropocene.

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