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I Like to Think of a Cybernetic Forest Filled with Pines and Electronics: Mergings of Plant and Technology in Contemporary Art

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ABSTRACT

Intertwining what can be seen as *environment* and *technology*, contemporary art often has a pioneering role in articulating new paradigms. Interlinking ecocritical claims with techno-utopian imaginations, artworks of this genre conceptualize ecosystems as sentient objects of investigation and as autonomous, agential counterparts to a human audience. This article explores how media imaginaries of environmental connectedness might arise or can be imagined in artistic practices through the entanglement of technology and plants or forest ecosystems. In looking at three different artistic case studies, the article investigates how plant bodies and forest ecosystems as well as technological devices are conceptualized, arranged, and interlinked on a material level and explores the epistemologies and aesthetic traditions that the artworks relate to. Through deploying sensing technologies, imaging techniques, sensors, and recording devices, the three artistic case studies discussed in this article—*Perimeter Pfynwald* (Marcus Maeder, 2019), *Terra0* (Terra0, 2016), and *Variants* (Pierre Huyghe, 2022)—construct ecosystems as entities, explore logics of cybernetics and computation, and in doing so shape our imaginaries of our more-than-human environment.

PART ONE: FICTIONS OF ENVIRONMENTAL CONNECTEDNESS

'Sentience Without Senses'

In the short story "Vaster Than Empires and More Slow" by science fiction writer Ursula K. Le Guin, a group of scientists encounter an unknown planet at the margin of the known universe. The particularity of the alien planet is its huge forestland that covers almost the entire surface. When the scientists settle on the planet exploring the vast wooded landscape, they are captured by uncontrollable outbursts of fear. As their expedition continues, the scientists find out that the anxiety they perceive is somehow linked to the unknown forestland itself. One especially receptive group member tries to locate the origin of the affective outbursts: "I suppose I could feel the roots. Below me in the ground, down under the ground. [. . .] I felt the fear."[1] Over the course of their investigation, it transpires that all parts of the trees, and the forest as a whole, perceive the visitors via their emotional expressions, sending them back in a feedback system.

The strange ecosystem, as the scientists come to understand, has developed an interconnected consciousness, almost beyond human comprehension: "[. . .] sentience without senses. Blind, deaf, nerveless, moveless. [. . .] Presence without mind. Awareness of being, without object or subject."[2]

Literature scholar Ursula K. Heise understands "Vaster Than Empires and More Slow," which was published in 1971, as the allegorical articulation of a global ecological vision, which, as today, had gained importance at the time of its writing. Heise connects Le Guin's short story to other concepts of "one world-encompassing, sentient superorganism," such as James Lovelock's Gaia hypothesis puts forward the theory of homeostasis, suggesting that planet Earth is one single self-sustaining and reactive system.[3] Similarly, in his 1967 poem, writer Richard Brautigan imagines "a cybernetic forest," "filled with pines and electronics."[4] However, unlike the connectedness in "Vaster Than Empires and More Slow," Brautigan's connectedness is expressed through the merging of technology and nature. As a form of apotheosis of a technological apparatus, the poem ends with the phrase "and all watched over by machines of loving grace."[5] Heise emphasizes the importance of such concepts in their ambivalence between being romanticizations of global connectedness and useful mergers with a technological or ecological sublime.[6] What unites these fictions and models is that, according to Heise, they make no sense unless the underlying idea of their encompassing connectedness is understood.[7] A central question for Heise is how humans might be able to relate to such a "planet-wide organic 'network of communications.'"[8]

Taking these reflections on the merging of human and nonhuman sensing as a starting point, I am interested in the question of how aesthetic forms relate to such "environmental imaginations"[9] of connectedness through analyzing intimate encounters of technology and environments in contemporary art. While Le Guin's and Brautigam's literary imaginations, now over half a century old, are visions of a techno-utopian, total world, the selected case studies discussed in this article—*Perimeter Pfynwald* by sound artist and composer Marcus Maeder, *Terra0* by the eponymous artist collective, and *Variants* by visual artist Pierre Huyghe— take us into localizable forest ecosystems, which have been technologically augmented and aesthetically framed. Interlinking ecocritical claims with techno-utopian imaginations, the three case studies that I will discuss are site-specific artworks, which, on a material level, intertwine specific local environments and technological devices.[10] *Perimeter Pfynwald* observes a forest affected by drought and attempts to raise awareness for climate change through artistic translation of environmental data. In *Terra0*, a plot of forest is turned into a self-managed technonatural resource by linking it with digital infrastructure. Lastly, in the artwork *Variants*, Huyghe created a simulation of a forest, which continuously mutates and interferes with its physical doppelganger. The works differ greatly in their form: *Perimeter Pfynwald* is exhibited as an audio installation, *Terra0* operates mainly conceptually, while *Variants* is a process-based, site-specific environmental installation. The three case studies explore, represent, and construct ecosystems with the aid of technology, contributing to a discussion on the relationship between technology and environments. A common element of the three artworks is that they apply technology as a sensory link between nonhuman and human senses and sensory stimulation. Similar to the plants described by Le Guin and Brautigam, the three case studies examined display forest ecosystems as nonhuman subjects, whose agency is expressed through their merging with technology.

Contemporary art plays a pioneering role in articulating new paradigms and the selected case studies interest me in their articulation of cultural imaginaries. Art is in a way a seismographic tool to reflect current discursive tendencies as well as a speculative means to forecast and pre-enact possible future intertwinements of nature and technology. In this way, the three case studies can be seen as experimental sites or as artistic prototypes for alternative or future models of ecologies.[11] They range between treating plant ecosystems as objects of investigation or conceptualizing them as autonomous, sentient and agential counterparts, giving an ambivalent interpretation of connectedness between plant or. forest ecosystem and technological devices. To better describe the relation and transition *in-between* devices and plant bodies/forest ecosystem, I will be using the term *transduction* as used by Stefan Helmreich, describing "how sound changes as it traverses media, as it undergoes transformation in its energetic substrate (from electrical to mechanical, for example), as it goes through transubstantiations that modulate both matter and meaning."[12] Coming from sound studies, the term not only bridges "the distance between cultural analysis and technical description," but directs our thinking towards "the infrastructures through which the vibrating world is nowadays apprehended."[13] Exceeding the world of sounds, transduction can help us understand the processes of sensing and measuring in the generation of environmental data, including the transitioning between "hardware and software, silicon and glass, minerals and plastic, server farms and landfills" as well as leaves, roots, wood, cellulose, soil, and plant cells.[14]

Understanding artistic work as knowledge production, I try to uncover the concepts and imaginaries behind entanglements of plants and technology in contemporary art. How, in these artworks, are plant bodies and forest ecosystems as well as technological devices conceptualized, arranged, and interlinked on a material level?[15] What epistemologies and traditions of thought do they relate to? In my discussion of the three artworks, I will explore their aesthetic configurations, their meditic transductions as processes, which transgress the separated spheres of nature and culture into a realm of *natureculture* and in doing so shape cultural imaginaries of our more-than-human environment. Naturecultures are "localized, historical entanglements."[16] The term, coined by Donna Haraway, expresses that there can be no articulation of nature that does not rely on a corresponding culture and vice versa.[17]

Plant Sentience, Cyborgs, and Environmental Sensing

For a long time in the history of Western science, plants have been conceptualized as merely reactive to external stimuli, literally vegetating, without any ability to think, feel or act.[18] Only recently, with the support of the newly emerging interdisciplinary research field, *plant studies*, has the interest in the ontology of plants, the ethical and philosophical implications in relation to plants, and their importance in the development of human cultures gained momentum.[19] Researchers from the fields of philosophy, cultural studies, anthropology, science and technology studies, as well as art and literary studies conceptualize plants as "agentic and active participants in socioecological systems."[20] The question as to whether plants have some sort of consciousness is contested, and unsettles anthropocentric understandings of such processes. Recent findings in biology and a growing scientific interest suggest forms of plant communication, whose spectra of experience are imperceptible to the human sensorium.[21] In particular, Natasha Myers, Michael Marder, Vinciane Despret, and others discuss notions such as sentience, agency, intentionality, and consciousness in relation to plants. They associate plants with the capacity of active and agentive anticipation, with "phenomena of sense, sensation, and sentience," of thinking, of

temporal-spatial awareness, and memory.[22] To relate these human and nonhuman sensory capacities, technological extensions are used as sensing devices in artistic processes.

To describe the hybrid state of plant-technology intertwinements, the figure of the cyborg still seems to be a helpful concept. Against the background of feminist studies—in particular feminist science and technology studies—and coined in the 1980s by Donna Haraway, the cyborg is a hybrid, chimeric being, meant as both a metaphor, "a creature of fiction" as well as a matter of "lived experience."[23] Transgressing the division of *nature* and *culture* by being neither natural nor an artefact, it bridges the boundary between organic life and mechanical object and—if one thinks of the cyborg as inclusive of the digital realm—between physical and virtual. To my mind, it seems important to emphasize that in the case of the cyborg, the individual parts of different origins remain intact, they do not merge, rather they are closely coupled. The cyborg can be seen as both a promise and as a threat at the same time; it is an ambivalent figure, existing as an offspring of both warfare industry and the feminist utopian possibility of a being without origin and teleology.[24] In this article, the cyborgian conjunctions are not only between human and machine, but include plants and environments, technological devices, and human actants.

Since the early age of imaging and sensing techniques from outer space in the 1950s, computation has become terrestrial and operates "from within the contours of earthly space."[25] Computation has turned environmental and "environments become computational, or programmable" in reverse.[26] To understand these processes, media scholar Jennifer Gabrys emphasizes that it is crucial to bypass "an automatic understanding of sensors as merely detecting preformed environmental data as though there is a world of substantialist phenomena to be processed by a cognizing device."[27] Instead, Gabrys proposes prioritizing "how distinct environments and environmental relations emerge, take hold, and are programmed with and through these technologies."[28] In doing so, Gabrys describes how both computation technologies as well as environments are processual: "The *becoming environmental of computation* then signals that environments are not fixed backdrops for the implementation of sensor devices, but rather are involved in processes of becoming along with these technologies."[29] Building on the notion of *natureculture* and bridging the division between the organic and the machinistic, Damian White and Chris Wilberg's term *technonature* greater emphasizes the reciprocal dependence of all the components in a technonatural environment as well as its processual nature.[30] Similarly, in "Vaster Than Empires and More Slow," rather than picturing environmental connectedness "as a reassuring" and often romantic "(re)turn to Mother Earth," I am interested in conceptualizing my case studies as an ambivalent and "thoroughly mediated step for the human imagination."[31]

It is worth noting some of the bodily metaphors used by media scholars to describe the network of connections between environment and sensing technologies stress the sensual and thus the aesthetic character of the connectivity. Referred to as the "electronic skin" of planet earth,[32] the "planetary brain," and "planetary sensing fabric,"[33] these bodily metaphors relate back to mediatic imaginaries of global and environmental intertwinements through the coupling of environment and technology. Thinking through the work of Bruno Latour, there is a danger in these metaphors, as they imply an engineering approach that the earth should be subjected to.[34] In order to avoid conceptualizing the global as something that should "fulfill a function," in Latour's vision of Gaia, "there are neither parts nor a whole."[35] More important, sensors weave into the environment and themselves become part of the environment that they are exploring. Once again

staying close to Ursula K. Le Guin: "Sentience or intelligence isn't a thing, you can't find it in, or analyze it out from, the cells of a brain. It's a function of the connected cells. It is, in a sense, the connection: the connectedness."[36] Sentience—if it can be traced—can only be found in the connection. In the case of the artworks that I will investigate, it might lie in the connection *between* environment and technological device. It is through this connection *between* environment and sensor technology that imaginations and phantasies of connectedness become perceptible.

PART TWO: AESTHETIC FORMS AS ENVIRONMENTAL IMAGINERIES

Sonifying Environments

Birds chirping, frogs croaking, the sound of insects flying by, rushing water and sounds of wind moving through the leaves of trees. The artwork *Perimeter Pfynwald* by Marcus Maeder involved the site-specific placing of microphones and recording devices in a pine forest in the Alps threatened by drought. One hears a "natural soundscape"[37] sound that sits within the human hearing range stemming from an immersive multi-channel sound installation. Apart from this, there are two other piercing, rhythmically repeated sounds, which are not that easy to decipher: a whirring high and a very low tone slowly changing volume. The artist describes these two sounds as "voice[s] of the forest."[38]

Figure 1. ***Marcus Maeder,*** **Perimeter Pfynwald,** ***2019. Automatic environmental sound recorder at Pfynwald, Switzerland. Photo © Marcus Maeder.***

Perimeter Pfynwald was developed in the context of the artistic research project "Ecodata – Ecomedia – Ecoaesthetics" of Basel Academy of Art and Design FNHW Switzerland (2017 –

2020).[39] The aforementioned field recordings for the sound installation were collected in Pfynwald, an alpine coniferous forest in the Rhone valley located in the Southern part of Switzerland. Since the beginning of the 21st century, various Scotch pines (Pinus sylvestris) have been dying because of increasing periods of aridity.[40] In search of the concrete causes of the forest decline in relation to global warming, the artistic research project collaborated with biologists from the Swiss Federal Institute for Forest, Snow and Landscape Research WSL. Maeder installed automated audio recording devices in Pfynwald during the heatwaves that struck the region in summer 2018 to record different environmental sounds of the forest. The various devices were installed at different locations several kilometers apart from each other, all recording at intervals of ten minutes.[41] For the final composition, the recorded soundscapes were temporally and spatially compressed and played simultaneously from six loudspeakers dispersed around the exhibition space, and labeled with the six recording sites: Forest/Channel, Mountain Stream, Riverbank, Pondsite, Pond Underwater, Forest/Channel Soil.[42] In addition to these field recordings, the installation includes the sonification of environmental measurement data, which was collected by scientists of WSL. Data sets of air humidity and air temperature, collected at different locations in Pfynwald, are implemented to regulate the sound synthesis on the computer, which controls the installation setup, resulting in the two oscillating, piercing sounds.[43]

The effects of global warming on forests like Pfynwald are manifold, yet it is difficult for human senses to grasp the scope and temporal implications of environmental change.[44] *Perimeter Pfynwald* and similar artistic projects try to tackle this issue by applying environmental data in aesthetic processes in order to make environmental change graspable and understandable and thus to raise "awareness of the ecological."[45] In *Perimeter Pfynwald*, this process aestheticization of environmental data was accomplished by several procedures of transduction and editing: first, the acoustic signals in the forest were recorded and digitalized.[46] The digital audio tracks were cut, reassembled and temporally compressed in the editing process. This procedure was implemented in order to make audible (and therefore understandable) macro patterns in the recorded data, making it possible to experience the changing of the environment over a longer period of time.[47] Second, during the exhibition, the digital tracks were acoustically reproduced in the installation space through loudspeakers. A third procedure of aestheticization of environmental data operates on a much more speculative level. As mentioned, data sets that are linked to forest health indicators are used in the production of *Perimeter Pfynwald.* It is assumed that the decrease of humidity and the rise of air temperature correlates with the vulnerability of the forest ecosystem. In the programming of the soundscape these two parameters regulate the sound synthesis, resulting in the two oscillating, piercing sounds that are described, as mentioned above, to be the voice of the forest. Through this operation, it becomes "possible to experience how drought and heat have an acoustic effect on the forest in the course of climate change."[48] In the artwork, this experience operates on an affective level of suggestion as the link between the data and the sound is not revealed. Climate change in *Perimeter Pfynwald*, according to the developer of the artwork, shows one major effect on the forest ecosystem:

> it becomes quiet. The more intensively the heat and drought period develops in summer 2018, the less can be heard in the individual biotopes: The noise of the nearby river becomes quieter because it carries less water; mountain streams dry up. The fauna retreats, is less active and therefore quieter.[49]

As an effect in the installation soundscape, as air humidity drops the low sound becomes lower and lower, as temperature rises the high sound becomes higher and higher, until the two tones leave the audible spectrum of human hearing. Therefore, the voice of the forest eventually becomes silent.[50]

"Eco media," according to art historian Yvonne Volkart, project leader of "Ecodata-Ecomedia-Ecoaesthetics," are mediatic procedures specifically involved in the production of knowledge concerning the biosphere.[51] Their application as "sensing techniques" produces hybrid conjunctions between registering and transmitting media technologies and the material environment. They are supposed to increase human attention towards nonhuman actors.[52] Volkart emphasizes sensing as something tactile, physical, something to establish a connection, thus, she concludes, sensing techniques are *aesthetics of sensing.*[53] So "what exactly do eco media and eco data deliver or narrate [. . .]? How do they affect us? Do they trigger care, solidarity, and empathy [. . .]?"[54] As shown, in *Parameter Pfynwald*, the use of environmental data in the aesthetic process has an objective: A central motive of the artwork is the sonification and aestheticization of scientific data sets into immersive, atmospheric soundscapes with the suggestive power to "trigger" emotions of "care," and "solidarity" in the audience.[55] As a result, through the sonification of specific sites and data sets of the forest, the forest entity is constructed as an emotionalized and sentient yet cyborgian counterpart to the human audience. The forest is cyborgian in that it can only be heard through the process of transduction implemented by the technological apparatus. It is the soundscape itself that constructs the forest as a sentient entity and allows its voice to become real.

Augmented Ecologies

A plot of spruce forest in Brandenburg, Germany, thirty kilometers east of Berlin, is the first in a series of evolving prototypes of the art project *Terra0*, which aims to enable technologically-augmented ecosystems to govern themselves.[56] Initiated by Max Hampshire, Paul Kolling, and Paul Seidler in 2016, their first concept paper is provocatively titled "Can an augmented forest own and utilize itself?"[57] With the help of automated processes and smart contracting hosted on Ethereum blockchain, which regulate outputs and inputs of the assigned forest territory, the*Terra0* forest prototype sells licenses to fell its own trees.[58] Through these procedures, the forest accumulates capital and reallocates the valorization from third parties toward buying and therefore effectively "owning" itself. The ecosystem is connected to digital infrastructures and rendered capable of managing and extrapolating its own continuous growth process. This is achieved by using imaging techniques recorded by drones and satellites, which regularly monitor the *Terra0* territory in order to estimate the growth of the forest. Conceptually speaking, the forest is turned into a quasi-autonomous, self-evolving or even self-governing prototype—which, through the transductional work of the monitoring system, expresses, and imposes an agency of its own.[59] *Terra0* can be described as a prototype for the concurrence of natural environments with digital infrastructure.

Figure 2. ***Max Hampshire, Paul Kolling and Paul Seidler,*** **Terra0*****, 2016. Labeled flag in the forest of*** **Terra0. Photo © *Terra0.***

Conceived only on a conceptual plane, this first site-specific prototype of *Terra0* was never fully realized technically. However, it was followed by other models of plant-blockchain couplings through smart contracting implemented on a smaller scale.[60] A second realization of an augmented ecosystem, this time in collaboration with LAS Art Foundation, is scheduled to take place in 2024 in Berlin.[61] As real life data sets inform token dynamics, the artwork bridges the material sphere of the forest with a token system, which is as material as the non-virtual realm.[62] *Terra0* is thus a proposition for an augmented ecology or, using the terminology of Donna Haraway, a cyborgian interlacing of ecosystem and digital infrastructure, in which technological extensions reach between physical and virtual reality.[63] Although the first speculative prototype of *Terra0* has an ambivalent standing between being a piece of land art, a concept piece, and a commercial technology, I suggest approaching it from a sculptural perspective. The artwork follows an artistic lineage that interferes with social, urban, economic, and environmental relations, such as works by Joseph Beuys, Maria Eichhorn, Gordon Matta Clark, Cildo Meireles, and others[64] and engages with both the notion of the *social sculpture* by Joseph Beuys and the *Land Art* tradition, which emerged in the 1960s.[65]

The term *sustainability* was originally coined in forestry. It was first used by Hans Carl von Carlowitz in his work *Sylvacultura Oeconomica* published in 1713, and used to describe the usage of the natural resource wood in a way that only as many trees should be logged as can grow back through planned reforestation.[66] Such a use-oriented coinage already presupposes an economic dimension in plant-human relations; the forest-human encounter in this logic is an economic one. The conception of the forest of *Terra0* is similar, yet is shifted to the digital realm:

The "forest as a factory" is defined by its economic relationship to its human trading partners and can only secure its continued existence through its valorization.[67] As Paul Seidler explains, "[a] forest has an computationally measurable productive force; the market value of the overall output of the forest can be precisely calculated."[68] Following this logic, the practice of the maintenance of the forest—defined as an economic process—becomes automated. The forest conducts the labor of maintaining itself, resulting in the ecosystem's autonomy and self-sufficiency. In this view, unlike that expressed and explored by Ursula K. Le Guin and discussed above, the forest of *Terra0* is conceptualized as an autonomous autopoietic entity.[69] *Terra0* incorporates a linear and uni-directional time concept, which allows no deviation and in which natural growth is integrated into an automated business model.

There is another, more ambivalent interpretation of the artwork: The forest ecosystem of *Terra0*, as described by the artists, is a cyborgian being, part property, part natural entity, as well as a technologically augmented "hyper structure." That hyper structure can be understood as a "programmable, electronic infrastructure," which surrounds and at the same time permeates the forest.[70] Again, much like *Perimeter Pfynwald*, through the process of transduction of imaging techniques that interconnect the forest with digital infrastructure, the forest is constructed as an agentic entity. Identity in a blockchain related network is configured through addresses, yet the entity behind the address remains obscure, so everything possessing an address can be perceived as an (economic) actor.[71] Before the launching of blockchain, ownership was limited to natural or legal persons; the new technology thus opens up a vast legal grey area, where ownership does not necessarily require a natural or legal entity.[72] Therefore, the forest of *Terra0* is conceptualized as an entity that, through its connection to the Ethereum platform, is given the possibility to own itself; its forest identity gets blurred behind its blockchain code. As a legal concept, personhood is closely linked with ownership and the question of who or *what* is granted personhood is therefore highly contested.[73] Through the loophole of an anonymizing blockchain address, the forest of *Terra0* is not only turned into the owner of itself but potentially also into an *environmental personhood*.[74] In the words of its inventors, aims to establish an "ecosystem resilience framework," and the artwork's construction as a service-providing ecosystem enables the construction of the forest as a legal entity, which has the power to control and defend itself. [75] Yet *Terra0* remains ambivalent by creating a system that at the same time calls itself into question: nonhuman agency is equated with human agency, instrumentalized and forced into a model of complete controllability and manageability.

Variants of a Landscape

Walking through the undergrowth of a boreal forest, one's attention is drawn to details: bare tree stems in various shades of brown, red, and grey, dense, dark green foliage that does not let much light pass, thorny shrubs and bushes, patches of moss in different greens and greys, yellow lichens covering rocks, fallen leaves and dried branches on the forest floor. Other elements found in this forest are not so easily categorizable: a pale pink bee nest hanging under a fallen tree trunk, a heap of pale bones lying on the forest floor, a group of amorphously shaped wax colored artifacts in a grove.[76] If one continues to walk through the thicket until the far end of the peninsula, one encounters a huge screen installed between trees. The screen shows artificially simulated fragments of the landscape it is placed in. The digitally rendered landscape is shown from a perspective which is too close to the ground to be human, constantly changing scale and focus, slowly modifying and regenerating forms and shapes.

Figure 3. ***Pierre Huyghe,* Variants*, 2021 - ongoing. Scanned forest, real-time simulation, generative mutations and sounds, intelligent camera, environmental sensors, animals, plants, micro-organisms and materialized mutations: synthetic and biological material aggregate. Courtesy of the artist; Kistefos Museum; Hauser and Wirth, London. Photo: Ola Rindal © Pierre Huyghe.***

The plot of land described above is located on a peninsula, surrounded by Randselva river in Jevnaker, fifty kilometers north of Oslo, Norway. Commissioned by Kistefos Museum, the artwork *Variants* by artist Pierre Huyghe was integrated into the existing forest landscape in 2022 and has been part of the museum's sculpture park ever since. Due to seasonal flooding of the island, the artwork is partially inaccessible throughout the year.[77] The artist and his team initiated the artistic process by mapping what they already found on the island: plant and animal species were charted by a biologist, the exact measurements of the territory were metered by a surveyor, "stones, plants, trees, insects, animals, rubbish, sounds and smells" were documented for later use.[78] Later, the peninsula was scanned using 3D technology and made available as a point cloud data set.[79] This virtual model forms the point of origin for the simulation, which is shown on the LED screen located on the island. The real time simulation is processed by artificial intelligence software, guided by a fictional narrative implemented by the artist, which diverges from "the island's natural laws."[80] Sensors, which are installed at various spots on the island, continuously feed the data they collect—information on local climatic changes and biochemical compositions—to AI software, thereby influencing the simulation and creating unpredictable mutations.[81] Every so often, as the simulation unfolds, mutations leave the virtual realm and, conceptually speaking, "leak back" into the reality on the island.[82] This means that selected mutations are processed by the artistic production team and become materialized as glitches between the two worlds, countless *variants* of the two coexisting realms in an interrelated co-evolving process.[83] According to the artistic team, the artwork creates two separate *"milieux"*[84]

evolving at the same time: one physical and one digital, which exchange and overlap, "bleeding into each other" and forming a mixed, porous and continuously recreative reality in an "endless feedback loop" of materialization and dematerialization.[85]

The real-time simulation of *Variants* with its proliferation into real space could be read as a form of *evolutionary* process that generates countless modifications and variations over an indefinite duration, which come into being, persist, and pass away. As opposed to *evolution,* which "fetishize[s] economic logics [. . .] and functionalist accounts of adaptation,"[86] Carla Hustak and Natasha Myers suggest the term *involution* to "inspire an approach that amplifies relations constituted through affinity" as well as through "the eruption of unexpected events."[87] Unlike evolution, this process is not determined by "descent and filiation" but by alliance.[88] Distinct from two clearly separated, autonomous individual ecosystems, the realities of the peninsula and of its virtual doppelganger join in a "block of becoming."[89] Anthropologist Anna Tsing is critical of approaches that regard landscapes as ahistorical static backdrops; she writes that "landscapes are historical, and they allow us to think across a variety of scales, from deep time to current events."[90] Furthermore, she explains how "axes of coordination"[91] emerge between different actors:

> [. . .] they find themselves with overlapping projects of world-making. Through such overlaps, a landscape emerges. Lots of other organisms, as well as non-vital things, occupy this landscape. But every time even a small coordination emerges, a moment of friction if you will, it has landscape-making effects. It gives the assemblage at least a momentary trajectory.[92]

Landscapes are therefore processual: following Tsing's as well as Hustak's and Myers's understanding, different axes of coordination enable the emergence of certain landscapes and block out others.[93] Conceptualizing landscapes as "historical mergings,"[94] *Variants*—understood as an artistic experimental zone of uncurated and curated processes made visible and perceivable—shows how specific landscapes emerge, are shaped and change in a continuous process of involution. All actors involved in this process, be it the pink bee hive, the sensors installed on the peninsula, the AI software, lichens and moss on the forest floor, the weather and the returning flood, the artistic team, and visitors co-produce ever-changing axes of coordination and trajectories in the making of the landscape of *Variants*. In exactly the same manner as the mutual conditionality of computation and environment cited at the beginning of this article, *Variants* shows unintended, uncontrollable, and uneven relations between diverse nonhuman and human actors, transduced by sensors, and evoked by the simulation.[95] As a counter-model to a precisely computable, technicist-cybernetic calculation, the forest ecosystem of *Variants* is conceptualized as an unpredictable cyborgian entity that incorporates everything—be it "natural," human or artefact—as part of itself in an involutionary process of diverse axes of coordination.

Aesthetics of Bewilderment

This article began by questioning how cultural visions of environmental connectedness might arise—or can be imagined—through the entanglement of technology and plants or forest ecosystems. In the case of the three artworks discussed above, the concepts of environmental connectedness were realized through processes of environmental sensing and transduction. The *technonatural* intertwinements in all three case studies evoked forest entities, which were conceptualized as active and agentic counterparts to their human observers. The three forest

entities were materialized differently: they were sonified in the case of *Perimeter Pfynwald*, performatively created through the conceptual setting and hidden behind a blockchain address in *Terra0*, or unfolded in a site-specific superposition of virtual realm and actual forest, grown plant material, and produced artifacts in *Variants*.

In *Perimeter Pfynwald*, the forest ecosystem is conceptualized as an emitting network. Through the translational work of sensing technologies, the effects of climate change are made perceivable, tangible, and understandable to human listeners; the forest is presented as a sensitive and vulnerable multispecies lifeworld, or in the words of the project organizers even "a patient in intensive care."[96] Through the soundscape, the emotions of the audience were focused on processes, which are normally unperceivable for the human sensorial spectrum and activated to show "care" and "solidarity." In contrast, *Terra0* deploys imaging techniques in order to monitor a plot of land; through this process the territory is valorized. Through its financialization, the forest is perceived to ally itself with the human economic system by becoming the proprietor of itself. One could compare this artwork to an autopoietic system, which, in contrast to a sympoetic entanglement, acts autonomously and in a predictable manner.[97] However, the forest's scope of action is restricted to a value-oriented logic and a linear temporality of extrapolating its own value. Nevertheless, *Terra0* must be understood as an ambivalent proposal: it raises the question of the interconnection of capitalist forces with ecosystems for their own protection as it confers upon the forest a state of environmental personhood and therefore touches upon the question of whether and how damaged environments could and should be restored. Thirdly, *Variants* shows how, through the interconnection of virtual and material milieux, landscape emerges as a process. With Tsing, this process can be described as historical mergings of various constantly changing axes of coordination of human and nonhuman trajectories. Involution, as opposed to evolution, inspires processes that are not guided by filiation and descent but are concerned with becoming through affinity and alliance.

While the forests of *Perimeter Pfynwald* and *Terra0* are conceptualized as agentic but predictable counterparts to their human observer (or much more listener), the forest of *Variants* is an encompassing yet erratic and obscure entity, which incorporates anything that enters the forest. In the three case studies, sensing technologies surround and permeate the forest environments to different degrees; in a sense, sensing technologies are *environing* the environment.[98] Through the various uses of sensors and recording technologies, transduction processes are initiated and environmental relations are produced.

"The woods can be 'lovely, dark and deep' [. . .], but they can also be the site of horror and danger, depending upon the traveler who passes through. [. . .] [T]hey offer refuge to some but disorientation to others" states queer theorist Jack Halberstam, who explains the origin of the term bewilderment as "[t]o lose in pathless places, to confound for want of a plain road."[99] Bewilderment, interpreted by Halberstam, expresses magical, delightful, and scary forms of not knowing and disorientation that we also associate with enchantment and confusion. According to Halberstam, it "suggests a becoming that moves in an opposite direction to [. . .] knowing, to navigation, to settling and conquering."[100] To different degrees, the environments of *Perimeter Pfynwald*, *Terra0*, and *Variants* are realms of bewilderment, producing affective and affecting processes of perception, of recognition and estrangement, predictability as well as disorientation:

> The "sensitive," "sentient," or "intelligent" plant of our current time is necessarily a post-natural mediated plant, a plant interposed by visual and other technologies that make their awareness and in-tuneness with other plants and their surroundings discernible to the rationalist eye. These are technologies that invite us to conceive the plant-other in intentional and overtly queer terms; technologies, [. . .] whose ultimate, paradoxical power has been [. . .] the ability to re-enchant a disenchanted world, to enhance our perceptual possibilities and suggest alternative, counter-hegemonic ways of thinking about the world.[101]

The question of the voice of the forest remains. How would the forest speak back? Can it be something that we understand or that we merely interpret? Does the voice of the forest, as mentioned in the discussion of the artwork *Perimeter Pfynwald*, express some sort of conscience, a call for connection, reconciliation or revenge?[102] The three artworks discussed reflect on the gap between the material presence of plants and the technological apparatus that is imposed upon them. Although all three case studies are equally speculative and inevitably anthropocentric, the aesthetic processes applied are themselves processes of interpretation, of narrating and creating "historical mergings," of sense-making, and of bewilderment.

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ENDNOTES

[1] Ursula K. Le Guin, "Vaster Than Empires and More Slow," in *Buffalo Gals and Other Animal Presences* (Plume, 1987), 113.
[2] Le Guin, "Vaster," 118.
[3] Ursula K. Heise, *Sense of Place and Sense of Planet: The Environmental Imagination of the Globe* (Oxford University Press, 2008), 19.
[4] Richard Brautigan, *All Watched Over by Machines of Loving Grace* (The Communication Company, 1967), 1.
[5] Brautigan, *All Watched Over by Machines of Loving Grace*, 1.
[6] See Heise, *Sense of Place and Sense of Planet*, 20. Another concept that could be linked to the imagination of global connectedness is the nineteenth century idea of the noosphere as an evolutionary process of "ascension of consciousness" on a global scale. The concept the noosphere was originally made popular through the philosopher Pierre Teilhard de Chardin in the early twentieth century. Oliver Krüger, "Gaia, God, and the Internet – Revisited: The History of Evolution and the Utopia of Community in Media Society" *Online – Heidelberg Journal of Religions on the Internet,* 8, (2015), 66, https://heiup.uni-heidelberg.de/journals/index.php/religions/article/view/20324/14118.

[7] See Heise, *Sense of Place and Sense of Planet,* 20.
[8] Heise, *Sense of Place and Sense of Planet,* 20. If we follow this thought of how humans might relate to a "planet-wide organic 'network of communications'" further, we arrive at the heart of the discourse around the pressing question of how the observing human subject can be moved from the center. This critique of an anthropocentric world view is articulated in posthumanist critique—voiced, for example, by Donna Haraway and Rosi Braidotti—as a concept of nature that is constructed as a peripheral alterity to a universal human subject. Their critique targets the construction of 'anthropos,' the conception of the human as a species and as expression of exceptionalist and individualist thought rooted in Western humanist philosophy, natural science and political economy. Humanist thought is equally criticized for establishing, through its normative function, a binary logic of identity and alterity as a driving force and cultural logic and consequentially defining this *other* as inferior. A whole range of *alterities* are included in this definition of inferiority, among them animals, plants, organisms, inorganic matter, and even entire ecosystems—simply the nonhuman environment. This binary division enables the immense form of influence on nonhuman life: The *other* is deprived of value on its own. In this perspective, the environment only exists through the interpretation of the normative subject, it is objectified, naturalized, or functionalized. For further elaboration on this topic, see Donna J. Haraway, *Staying with the Trouble: Making Kin in the Chthulucene* (Duke University Press, 2016), especially 30-57. Rosi Braidotti, *The Posthuman* (Polity Press, 2023). Steven Shaviro, "Consequences of Panpsychism," In *The Nonhuman Turn,* ed. Richard Grusin (University of Minnesota Press, 2015).
[9] Heise, *Sense of Place and Sense of Planet,* 21.
[10] For a detailed discussion of the term site-specificity in the context of art history, see Miwon Kwon, *One Place After Another: Site-Specific-Art and Locational Identity* (MIT Press, 2004).
[11] The term *ecology* indicates "the massive and dynamic interrelation of processes and objects, beings and things, patterns and matter." Matthew Fuller, *Media Ecologies: Materialist Energies in Art and Technoculture* (MIT Press), 2, quoted in Florian Sprenger, *Epistemologien des Umgebens: Zur Geschichte, Ökologie und Biopolitik künstlicher Environments,* (transcript, 2019), 22. The term stresses a non-dualist encounter of nature and technology, human and nonhuman as well as a relational, dynamic and processual understanding of our surroundings. See Sprenger, *Epistemologien des Umgebens,* 9-60.
[12] Stefan Helmreich, "transduction," in *keywords in sound*, ed. David Novak and Matt Sakakeeny (Duke University Press, 2015), 222.
[13] Helmreich, "transduction," 223 and 226.
[14] Jennifer Gabrys, *Program Earth: Environmental Sensing Technology and the Making of a Computational Planet* (University of Minnesota Press, 2016), 4.
[15] Originally, the term ecosystem is a biological concept, coined by Raymond Lindeman in 1942, defined as a "system composed of physical-chemical-biological processes active within a space–time unit of any magnitude." Raymond L. Lindeman, "The Trophic–Dynamic Aspect of Ecology" *Ecology* 23, no. 4 (October 1943): 400, quoted in A. J. Willis, "Forum," *Ecology* 11, no. 2 (April 1997): 268. In this original sense the term was invented to interpret data of dynamic ecology (see Willis, "Forum," 268) and therefore conveys the idea of a system based on feedback mechanisms, comparable to a cybernetic understanding of systems.
[16] Anna-Sophie Springer and Etienne Turpin, "Naturecolony – an exhibition-led inquiry into the colonial history of the market," Reassembling Nature, accessed November 15, 2023, https://reassemblingnature.org/naturecolony/.

[17] See Donna J. Haraway, *The Companion Species Manifesto* (Prickly Paradigm Press, 2003).
[18] See Urte Stobbe, "Plant Studies: Pflanzen kulturwissenschaftlich erforschen – Grundlagen, Tendenzen, Perspektiven," *Kulturwissenschaftliche Zeitschrift* 1 (2019): 93, https://doi.org/10.25969/mediarep/16150. Natasha Myers, "Conversations on Plant Sensing: Notes From the Field," *NatureCulture* 3 (2015): 43.
[19] See Stobbe, "Plant Studies," 95.
[20] John C. Ryan, "Passive Flora? Reconsidering Nature's Agency through Human-Plant Studies," *Societies* 2, no. 3 (December 2012): 110, https://doi.org/10.3390/soc2030101, quoted in Stobbe, "Plant Studies," 97. Some of the protagonists of the field of *plant studies* are Giovanni Aloi, Daniel Chamovitz, Emanuele Coccia, Matthew Hall, Michael Marder, Natasha Myers, Robin Wall Kimmerer, and Patrícia Vieira to only name a few.
[21] See Stobbe, "Plant Studies," 9 und Myers "Conversations on Plant Sensing," 40f.
[22] Myers, "Conversations on Plant Sensing," 43. For the term *agency* see Myers, "Conversations on Plant Sensing," 43 and Vinciane Despret, "From Secret Agents to Interagency," *History and Theory* 52, no. 4 (2013). For *plant memory* see Michael Marder "What is Plant-Thinking?" *Klesis — revue philosophique* 25 (2013): 126 and 135.
[23] Donna Haraway, "A Cyborg Manifesto: Science, Technology and Socialist-Feminism in the Late Twentieth Century," in *Simians, Cyborgs and Women: The Reinvention of Nature* (Routledge, 1991), 149.
[24] Haraway, "A Cyborg Manifesto," 149.
[25] Gabrys, *Program Earth*, 7.
[26] Gabrys, *Program Earth*, 9.
[27] Gabrys, *Program Earth*, 9.
[28] Gabrys, *Program Earth*, 10.
[29] Gabrys, *Program Earth*, 9, cursive in original.
[30] See Damian White and Christ Wilbert, "Introduction: Technonatural Time–Spaces," *Science as Culture* 15, no. 2 (June 2006), https://doi.org/10.1080/09505430600707921.
[31] Heise, *Sense of Place and Sense of Planet,* 20.
[32] Neil Gross, "The Earth Will Don an Electronic Skin," *Business Week,* August 30, 1999, http://www.businessweek.com/1999/99_35/b3644024.htm, quoted in Gabrys, *Program Earth,* 6.
[33] Gabrys, *Program Earth,* 7.
[34] See Bruno Latour, *Facing Gaia: Eight Lectures on the New Climatic Regime* (Polity Press, 2017), 95.
[35] Latour, *Facing Gaia*, 95, original in italics.
[36] Le Guin, "Vaster Than Empires and More Slow," 118.
[37] Raitis Smits, "IRXC Festival 2020 Exhibition ECODATA. Guided tour," RIXC Centre for New Media Culture Riga, video, 7:30, https://vimeo.com/479891978.
[38] "*Perimeter Pfynwald*: A Soundscape Observatory by Marcus Maeder, 2019," Academy of Art and Design FHNW, accessed October 30, 2023, https://www.fhnw.ch/de/forschung-und-dienstleistungen/gestaltung-kunst/forschung/forschungsprojekte-iagn/ecodata-ecomedia-ecoaesthetics/research-project/perimeter-pfynwald.
[39] See "Ecodata-Ecomedia-Ecoaesthetics," Academy of Art and Design FHNW, accessed October 30, 2023, https://www.fhnw.ch/de/forschung-und-dienstleistungen/gestaltung-kunst/forschung/forschungsprojekte-iagn/ecodata-ecomedia-ecoaesthetics.
[40] See Swiss Federal Institute for Forest, Snow and Landscape Research WSL, "Long-term irrigation experiment Pfynwald," accessed October 30, 2023, https://www.wsl.ch/en/about-wsl/instrumented-field-sites-and-laboratories/experimental-sites-in-forests/pfynwald/.

[41] See "*Perimeter Pfynwald*: A Soundscape Observatory by Marcus Maeder, 2019."
[42] See Yvonne Volkart, "Spürtechniken: Von den Medien der Naturvermittlung zu den Ästhetiken des Spürens," *Medienobservationen* (April 2020): 5.
Perimeter Pfynwald was shown at the exhibition *Critical Zones: Observatories for Earthly Politics* curated by Bruno Latour, Peter Weibel, Bettina Korintenberg et al. at ZKM Zentrum für Kunst und Medien Karlsruhe. A digital representation of the exhibition can be found here: https://critical-zones.zkm.de/#!/detail:perimeter-pfynwald-a-soundscape-observatory accessed October 30, 2023.
[43] See "*Perimeter Pfynwald*: A Soundscape Observatory by Marcus Maeder, 2019."
[44] See Swiss Federal Institute for Forest, Snow and Landscape Research WSL, "Long-term irrigation experiment Pfynwald."
[45] "Ecodata- Ecomedia-Ecoaesthetics." An artwork, which was produced in the same frame of "Ecodata-Ecomedia-Ecoaesthetics" was *Atmospheric Forest* by artist Rasa Smite, for more information see the artist's project webpage, Rasa Smite and Raitis Smits, "Atmospheric Forest," accessed November 9, 2023, https://smitesmits.com/AtmosphericForest.html.
[46] For the term of digital objects, see Yuk Hui, "Deduktion, Induktion and Transduktion: Über Medienästhetik und digitale Objekte," *Zeitschrift für Medienwissenschaft* 8, no. 1 (2013).
[47] See Smits, "IRXC Festival 2020 Exhibition ECODATA. Guided tour," 7:44.
[48] "*Perimeter Pfynwald*: A Soundscape Observatory by Marcus Maeder, 2019."
[49] "*Perimeter Pfynwald*: A Soundscape Observatory by Marcus Maeder, 2019."
[50] See "*Perimeter Pfynwald*: A Soundscape Observatory by Marcus Maeder, 2019."
[51] Volkart, "Spürtechniken," on the term of *eco media*, see also Sean Cubitt, *Eco Media* (Rodopi, 2005).
[52] See Volkart, "Spürtechniken," 2f.
[53] See Volkart, "Spürtechniken," 3.
[54] "Ecodata-Ecomedia-Ecoaesthetics."
[55] "Ecodata-Ecomedia-Ecoaesthetics." See the definition of atmospheres as "affective powers of feeling, spatial bearers of moods", Gernot Böhme, "Atmosphere as a Fundamental Concept of a New Aesthetics," *Thesis Eleven* 36 (1993): 120.
[56] See Terra0, "The Development of Terra0: Experiments with Autonomous Ecosystems" *Weird Economics Journal W.E*, June 12, 2021, https://weirdeconomies.com/contributions/the-development-of-terra0.
[57] Paul Seidler, Paul Kolling and Max Hampshire, "Can an Augmented Forest Own and Utilize itself?" May 2016, published online, https://terra0.org/assets/pdf/terra0_white_paper_2016.pdf.
[58] For more information on Ethereum see Thomas Osterland and Thomas Rose, "Model checking smart contracts for Ethereum," *Pervasive and Mobile Computing* 63 (March 2020), https://doi.org/10.1016/j.pmcj.2020.101129.
[59] See Martina Raponi, "*Terra0*, the augmented self-owned forest," *Digicult Online Journal*, March 14, 2017, https://digicult.it/news/terra0-la-foresta-aumentata-indipendente/.
[60] *Flowertokens* located at Trust (2018) in Berlin (https://flowertokens.terra0.org), followed by *Premna Daemon* (2018) at Schinkel Pavillon Berlin (https://premna.terra0.org/) and by *Seed Capital* (2022) at Art Dubai, see "The Development of Terra0".
[61] E-mail exchange with Paul Kolling of "Terra0", October 9, 2023.
[62] See Simon Denny, *Seed Phrase*, podcast, "Terra0 on Economies Beyond the Human," with Paul Kolling and Paul Seidler, The New Institute,, 8 May 2023, https://thenew.institute/en/media/seed-phrase/01-terra0-on-economies-beyond-the-human.

[63] *Augmented Ecology* is a term which is circulating, but has not yet been given an overarching definition, see the definition of "Augmented Reality" in Paul Milgram, Haruo Takemura, Akira Utsumi, and Fumio Kishino, "Augmented reality: A class of displays on the reality-virtuality continuum," *SPIE – The International Society for Optical Engineering* 2351 (January 1994): 282-292, 283, https://doi.org/10.1117/12.197321.
[64] See Seidler, Kolling and Hampshire, "Can an Augmented Forest Own and Utilize itself?" 1.
[65] On the notion of the social sculpture, see Wolfgang Zumdick, "U-topos: Beuys's Social Sculpture as a Real-Utopia and Its Relation to Social Practice Today" in *A Lived Practice*, ed. Mary Jane Jacob and Kate Zeller (Chicago University Press, 2015). On the notion of land art and its historical embedding, see Philipp Kaiser and Miwon Kwon, *Ends of the Earth: Land Art to 1974* (Prestel, 2012).
[66] The term first used for sustainability was *Nachhaltigkeit,* see Hans Carl von Carlowitz, *Sylvicultura Oeconomica, Oder Haußwirthliche Nachricht und Naturgemäßige Anweisung zur Wilden Baum-Zucht* (Braun Verlag, 1713), https://digital.slub-dresden.de/werkansicht?id=5363&tx_dlf%5Bid%5D=85039&tx_dlf%5Bpage%5D=1. For the term sustainability or Nachhaltigkeit see also Ulrich Grober, *Die Entdeckung der Nachhaltigkeit: Kulturgeschichte eines Begriffs* (Antje Kunstmann Verlag, 2013).Charles V. Kidd, "The Evolution of Sustainability" *Journal of Agricultural and Environmental Ethics* 5, (March 1992). Joachim Radkau*, Holz. Wie ein Naturstoff Geschichte schreibt* (Oekom Verlag Stoffgeschichten, 2007).
[67] Denny, "Terra0 on Economies Beyond the Human," 17:30.
[68] Raponi, "Terra0, the augmented self-owned forest."
[69] For a definition of Autopoiesis, see footnote 104.
[70] Denny, "Terra0 on Economies Beyond the Human," 16:30.
[71] See Denny, "Terra0 on Economies Beyond the Human," 9:30 –10:30.
[72] See Denny, "Terra0 on Economies Beyond the Human," 11:30.
[73] With his text first published in 1972, Christopher D. Stone launched a discourse on the question of whether environments should have natural rights, see Christopher D. Stone, *Should Trees Have Standing: Law, Morality and the Environment* (Oxford University Press, 2010). For the current discourse on environmental personhood, see e.g. Visa A.J. Kurki, "Can Nature Hold Rights? It's Not as Easy as You Think," *Transnational Environmental Law* 11, no. 3 (November 2022): 525–552, https://doi.org/10.1017/S2047102522000358. Visa A.J. Kurki, *A Theory of Legal Personhood* (Oxford University Press, 2019). Andreas Fischer-Lescano, "Nature as a Legal Person: Proxy Constellation in Law," *Law & Literature* 32, no. 2 (2020).
[74] In this regard, *Terra0* raises a series of highly interesting questions: What are the conditions for a forest to possess itself? Do we have to re-value labor performed by nonhuman entities? What value do we assign to nature? How can the conservation of ecosystems be realized outside of a value-based system or beyond human influence? How can growth be conceptualized in times of climate crisis? These issues that *Terra0* raises are closely related to discourses on *ecosystem services*, which essentially assume that ecosystems, forests, peatlands and other ecosystems provide certain services for human use, which need to be managed sustainably in order to keep "natural capital available for future generations." (UNECE: "Ecosystem Services" accessed November 23, 2023, https://unece.org/ecosystem-services-0). Ecosystems in this logic are managed and at the same time protected e.g. through certificate trading. PINA EARTH, "Protecting the global climate with local forest," accessed November 23, 2023, https://www.pina.earth/en.
[75] "Terra0", accessed November 20, 2023, https://terra0.org/.

[76] See En Liang Khong, "The Poetics and Pitfalls of Allegorithmic Art," *Art Review*, July 28, 2022, https://artreview.com/the-poetics-and-pitfalls-of-allegorithmic-art-pierre-huyghe-kistefos/.
[77] See "Unveiled 2022, *Variants* by Pierre Huyghe," Kistefos Museum, accessed November 15, 2023, https://www.kistefosmuseum.com/sculptur/variants.
[78] "Unveiled 2022, *Variants* by Pierre Huyghe."
[79] "Unveiled 2022, *Variants* by Pierre Huyghe."
[80] "Unveiled 2022, *Variants* by Pierre Huyghe."
[81] See Ina Blom, "Possibility of an Island," *Artforum* 61, no. 3 (November 2022), https://www.artforum.com/columns/ina-blom-on-pierre-huyghes-_variants_-252193/.
[82] Khong, "The Poetics and Pitfalls of Allegorithmic Art."
[83] See "Unveiled 2022, 'Variants' by Pierre Huyghe."
[84] *Milieu*, used by the artistic team to describe the interrelation between physical and virtual space, is a loaded term. In addition to Georges Canguilhem, the term was also coined by Gilbert Simondon and Michel Foucault "as a way to variously describe spaces of transfer, influence, and environmental inhabitation." Especially Simondon's understanding of the interaction in between *milieux*, according to Jennifer Gabrys' interpretation, describes "processes whereby environments and entities are formed across individuals (inner) and environments (exterior) through energetic and material exchanges that occur through the transversal field of the associated milieu," Gabrys, *Program Earth,* 12.
[85] Khong, "The Poetics and Pitfalls of Allegorithmic Art."
[86] Carla Hustak and Natasha Myers, "Involutionary Momentum: Affective Ecologies and the Sciences of Plant/Insect Encounters," *d i f f e r e n c e s: A Journal of Feminist Cultural Studies* 23, no. 3 (2012): 97, https://doi.org/10.1215/10407391-1892907.
[87] Elizabeth Grosz, *The Nick of Time: Politics, Evolution, and the Untimely* (Duke University Press, 2004), 8, quoted in Hustak and Myers, "Involutionary Momentum," 94.
[88] Gilles Deleuze and Félix Guattari, *A Thousand Plateaus: Capitalism and Schizophrenia* (University of Minnesota Press, 1980) 38, quoted in Hustak and Myers, "Involutionary Momentum," 97.
[89] Gilles Deleuze and Félix Guattari, *A Thousand Plateaus: Capitalism and Schizophrenia* (University of Minnesota Press, 1980) 38, quoted in Hustak and Myers, "Involutionary Momentum," 97.
[90] Anna Tsing, "The Buck, the Bull and the Dream of the Stag: Some Unexpected Weeds of the Anthropocene," *Suomen Antropologi: Journal of the Finnish Anthropological Society* 42, no. 1 (Spring 2017): 7f.
[91] Tsing, "The Buck," 16.
[92] Tsing, "The Buck," 14. For the term *friction* See Anna Tsing, *An Ethnography of Global Connection* (Princeton University Press, 2005).
[93] See Tsing, "The Buck," 14.
[94] Anna Tsing, *The Mushroom at the End of the World. On the Possibility of Life in Capitalist Ruins* (Princeton University Press, 2015), 238.
[95] See Gabrys, *Program Earth,* 9.
[96] Yvonne Volkart, Rasa Smite, Arthur Gessler and Kaisa Rissanen, "Terrestrial University: Visualizing Forest Ecosystems," conversation in the frame of the exhibition *Critical Zones: Observatories for Earthly Politics*, Zentrum für Kunst und Medien ZKM, September 16, 2021, https://zkm.de/de/media/video/terrestrische-universitaet-visualisierung-von-waldoekosystemen.

[97] "Autopoietic systems are 'self-producing' autonomous units 'with self defined spatial or temporal boundaries that tend to be centrally controlled, homeostatic, and predictable.'" M. Beth Dempster, "A Self-Organizing Systems Perspective on Planning for Sustainability," MA thesis, Environmental Studies, University of Waterloo, 1998, quoted in Haraway, *Staying with the Trouble*, 61. Opposed to this, Donna Haraway quotes M. Beth Dempster in using the term *Sympoiesis* to define systems that "do not have self-defined spatial or temporal boundaries. Information and control are distributed among components. The systems are evolutionary and have the potential for surprising change."
[98] See Sverker Sörlin and Nina Wormbs, "Environing technologies: a theory of making environment," *History and Technology* 34, no. 2 (December 2018): 101–125, https://doi.org/10.1080/07341512.2018.1548066.
[99] Jack Halberstam, "Bewilderment," *Harvard Design Magazine*, no. 45 "Into the Woods", 2018, http://www.harvarddesignmagazine.org/articles/bewilderment/.
[100] Halberstam, "Bewilderment.".
[101] Teresa Castro, "The Mediated Plant," *e-flux,* no. 102 (September 2019): 3, https://www.e-flux.com/journal/102/283819/the-mediated-plant/.
[102] For a discussion of the term *haunting* of nonhuman entities see Eve Tuck and C. Ree, "A Glossary of Haunting," in *Handbook of Autoethnography,* ed. Stacey Holman Jones, Tony E. Adams, and Carolyn Ellis (Left Coast Press, 2013), 639-658. Heather Davis, "Plastic Media," *e-flux,* no. 126 (April 2022): 7, https://www.e-flux.com/journal/126/458489/plastic-media/.

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