Earth-Centered Communication Technology (Earth Tech Net) is a framework that aims to shift technological value systems away from the normative human and toward planetary-aware ecological inclusivity. The framework grounds computational media as part of ecological evolutionary forces. It also generates experimental artworks that can reveal the current limitations of technological value systems and how they shape human behavior at different scales, as well as create models of an ecologically focused paradigm of technology, for example, an augmented-reality (AR) lichen interface made to model a hypothetical Earth-communication device that connects different species together.

The work of both artists and technologists has expanded the bounds of what human communication, expression and connection means. This expansion is representative of nothing short of our ongoing social evolution as a species, as our “complex intelligence” is associated with an increase in social complexity [1], the ability to transmit information—about ourselves and our environments—to each other. However, as we depreciate further into climate change, extinction and eco-crisis, there is another missing key to our survival as humans: our ability to connect with and live in a sustainable, reciprocal way with other species and the ecological structures that have sustained us for thousands of years on Earth. Moreover, true “connectedness” is not only human to human, but it is also humans in shared spaces, spaces with temperature, ground forms, air, sounds and often shared with other organisms such as plants, bacteria, birds, fungi and more. The Earth-Centered Communication Technology framework suggests that artists and technologists shift away from a “humans-alone” mentality and work to expand the meaning of “connectedness” with Earth and its life forms. The framework also suggests that, from an evolutionary science perspective, our ability to understand, coevolve, communicate and interact mutually beneficially with other species is now an imperative.

When artistic work utilizes current technological systems critically, it can help to expose the underlying value systems that may be shaping behaviors, limiting communicative forms, narrowing our collective focus and contributing to ecological damage on a larger scale. Technological systems change quickly, and therefore the underlying values also need consistent reevaluation, as the lack of precedents in ethical norms allows for novel systems to function without the scrutiny of the greater public [2]. This means that it is more necessary than ever that artists are able to access and work with new technologies, even in sloppy ways, to delegitimize the technologies’ status as a black box that “just works” and otherwise goes unquestioned. An Earth-centered perspective is generative of many shifts: that we deep learn “from the land” [3] and its ecological networks (Fig. 1), that we privilege the needs of total ecological health as opposed to those of a specific privileged class of humans alone and that we design interfaces and algorithms that could benefit ecological systems, such as with increased modularity of parts or computations that include ecological big data from atmospheric and biodiversity models, for example. By continuing to develop practices of “critical use” with technologies, we can encourage shifts in our collective expectations of communication devices and—through ecological representation within communication networks—our understanding of the intrinsic value of other species on Earth. Simply by representing other beings within media networks, we can shift collective attention and expand our technocultural values from extractive to mutual.

The word technology is a broad term, and it seems increasingly useful for profit-oriented forces to abstract such terms (like technology and AI), leading to deferral and black-boxing. Most current massively distributed technological devices are proprietary and designed without modular components; this is accepted as a strategic business model [4]. The lack of large-scale modularity in our electronics has major waste ramifications, and it seems odd that this is not part of the
deeper calculations with which design decisions are made at the outset. Producing excess waste in the service of “updat- ing” is a strategic failure. This failure gets subsumed behind a mythology and aesthetics of efficiency: “sleekness” in design. What does “efficient” mean when the data of its waste production is omitted? The industrial legacy on planet Earth is not only nuclear waste [5], but, as we enter a “nuclear-moment of technology” [6]—that is to say, participation in the construction of something severely damaging to life—regarding surveillance, a legacy of meltingly hot data centers and the tech industry’s piles of planned obsolescence–based waste. If we can plan for obsolescence we can plan for reuse. Hardware is thought of as “dead,” yet its remnants are very much undead—its effects on Earth persist [7].

We, those who identify as “on the inside” of a corporate entity, startup or art-tech project, for example, designers, engineers, physicists, computer scientists, consultants and artists contributing to the development of technology—from obscure prototypes to technology used on a daily massive scale—hold a special responsibility in terms of these technologies’ encoded values. We, from the specialists to the tinkerers behind technological evolution, are the ones with the “hand in glove,” consciously or not, whether we are cognizant of the larger intent behind a project, which may be large-scale surveillance and the various steps involved in it, and whether we can defer to user behavior, such as users having signed an agreement or having behaved a certain way as a result of the technological affordances, or not. Our collective behaviors and choices can shape both value systems and resultant technologies. The Gibsonian affordances [8] and lack of affordances of a device represent a kind of behavioral state space, and this state space is directly shaped by design decisions. The structure of technological devices and larger-scale technological systems encode values and meanings into it [9]. Technology is not neutral [10], especially in relation to both its nonphysical behavioral impacts and its physical impact on the environment. This includes its propensity to become obsolete, its production cost and its full life cycle’s net effect. Data is currency [11], machine learning is an extractive form and further analysis upon that data is an epistemological regime [12,13]. We have a responsibility to address the full implications of a technology’s state space: how it influences human behavioral psychology, how it impacts other humans and other species outside of its profiled user and how it impacts the surrounding environment over its whole life cycle.

While predictive analysis is applied to almost any phenomenon and held up as accurate, a major prediction is on a back burner: climate change. Increased extinction, loss of diversity and climate refugees are right before our eyes. Many tech companies have the audacity to make appeals to the future or “designing for the future” [14] while there is a present tense future clearly delineated by the predictions of climate scientists. Can we really design for that future from within the corporate-pervasive paradigm of resource extraction?

From “human activity tracking” to “psychographic profiling,” technologies seek to “increase efficiency” by personalizing to human needs, extracting data from our experiential affect. Personalization is human-centered: a system that adapts to individual human needs, as opposed to any greater picture—an ecological system’s “needs.” We are not only appealing to a false “human” whose needs are privileged over other humans and other species, we are further generating a false second self, the “digital double” [15], who is a collection of inferences over behavioral data, for example, which the user may have never consented to, does not see and never has the opportunity to confirm for accuracy. This reveals that so far we value extraction and inference on its own without counting its validity vis-à-vis the actual being. For example, if we had a centralized public data resource that was updated regarding ecological states and biodiversity data, then we could avoid situations in which corporate entities extract their own inferences to meet their interests [16,17]. So far inferences are used without regard for the total effects of that inference. Perhaps we need to ask again whether trees should have a legal standing, given that corporate entities do [18]. Perhaps it is time for all disciplines to prioritize the ecological, our interspecies and interland relationships.

In addressing the flaws of our techno-cultural, techno-industrial moment, in which many of us can only partially see the trajectory of our own contribution (even as users) to major ethical uncertainties—such as systems of mass surveillance that contribute to the disproportionate targeting of Black and Brown people, the major energy use cost of data centers and degrading environmental effects due to mining and development—Earth-centeredness at least serves to demarcate the potential for a change in direction and lend the critical distance necessary to notice the pressures that have led us to this moment and how it could be different. Critical practices can help us to shift the resource-extractive value systems that are perpetuated within the quality of tech-mediated social interactions necessary for interfacing in our current systems.
The Earth-centered framework has emerged in response to these issues, which have come to the forefront during an ongoing collaboration between Nokia Bell Labs, Leonardo/ISAST and me, as the inaugural artist of the California-based Experiments in Art Technology (E.A.T.) artist residency on Muwekma Ohlone land. The framework is grounded by several key concepts that represent a shift in values. The first, and most foundational, is Deep Ecology’s philosophical stance that other organisms have intrinsic value, meaning that a tree is valuable for its being a tree, regardless of the tree’s impact on humans or as a resource to human beings [19]. What would it mean to encode this notion across networks? What would be the crucial problems to solve algorithmically, if resource extraction was secondary? What would our communication devices look like if this premise was centered? Another key idea is Jussi Parikka’s, that technology literally comes from the minerals of Earth [20]. A third key foundation is the indigenous pedagogical approach of “learning from the land” [21]. A hierarchical notion of humans as separate from and above the rest of “nature” is a causal justification for capitalism in its most resource-extractive form [22], a form that is no longer acceptable given eco-crisis. This means it is crucial to reframe the idea that humans are “more intelligent”; rather, the seat of “intelligence” could be thought of as the ecological network, since it is ecology from which the human mind has emerged. This idea implies that artificial intelligence is misguided when it is based on human-centered notions of intelligence alone. Perhaps we can learn about “intelligent” behaviors by more deeply understanding how self-sustaining ecological networks emerge, sustain and evolve. This concept inspired my video work Deep Learning from the Land (Color Plate A).

We live in a socio-technical moment when meteorological information about Earth’s atmosphere is in competition for radio frequency bandwidth with 5G networks [23]. While this issue may be technically resolved, it shows us that we are in a time when our human-to-human communication and atmosphere-to-human communication networks are segregated and sometimes at odds. The right to information transmission is a battle zone, and information transmission is key to our evolution. When we look at what occupies bandwidth, we see what is prioritized in terms of the representation of information across networks. Our collective interaction with Earth and Earth systems is not integrated into or represented in our networked daily lives. Earth-Centered Communication Technology attempts to give notice of and address this gap. Algorithms could be informed by ecological data, for example, and since no learning algorithm is yet unbiased, in theory it could be bio-biased or “ecobiased”—biased in such a way as to favor inclusive biodiversity.

In thinking through networks and ecology, I used the complexity of lichen organisms as a model for a naturally occurring “interface” between scales of Earth-based information. Lichen is a hybrid organism made up of a mutualistic relationship between fungal filaments and algae and/or cyanobacteria, itself a microecology that supports species of many kinds. Lichen is a natural infrastructural support in that it provides surface area for biodiversity, as housing for insects and as living building material for bird nests. It also “interfaces” with atmospheric gases and serves as a natural biomonitor to reveal sites of pollution, as it will change color based on the atmospheric gaseous content. Lichen is also passive; it grabs onto trees and rocks but does not extract from them.

Taking lichen as a source of inspiration, I created an art installation as a prototype for a lichen-to-human interface that “speaks” with lichen organisms, through a feedback combination of water vapor, light, computer vision and algorithmic modeling. The intent was to show a looping interaction between algorithmic processing and a living organism, within a human-accessible context (the art gallery), in order to emphasize how human experience is unbounded and inextricable with the shared geological space and time that includes other species. The lace lichen (Ramalina menziesii) and greenshield lichen (Flavoparmelia caperata) were locally sourced from and then returned to San Francisco’s Golden Gate Park after the installation’s run, with returning being a key aspect of the life cycle of resource-use practices. These particular lichens likely continue to survive there now. In the installation, a webcam livestreams the lichen arranged on a geospatially inspired sculptural panel. The lichen’s images are processed, and the augmented processed images are projected back onto a second sculptural form for human visual access. The total installation (Fig. 2) is a cycle that (1) gets information about the lichen from the visual stream of the webcam, (2) uses computer vision processes (contour tracking and color tracking), (3) “communicates” back to the lichen by turning on and off a power circuit that modulates the light and water vapor output and (4) is completed as the light and water affect the lichen and their visual information changes in the webcam. As research for the piece I attempted to implement what I have called “ecobias” by training neural networks (convolutional neural networks, generative adversarial networks) on images of rocks and minerals from www.MinDat.org and images of lichen from the Consortium of North American Lichen Herbaria as well as species distribu-

Fig. 2. Earth-Centered Communication Technology: AR Lichen Interface installation, collected lichen, redwood sculpture, water misters, lighting, webcam, projection mapping, 2019. (© Julia Litman-Cleper) The superimposed arrows on this photograph of the installation indicate a closed cycle of information between the lichen panel and the responding lights, water and projection mapping panel.

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tion data from www.iNaturalist.org. This data is superficial in that it only involves the visual modality, not deeper signals. The potential future goals of this work are to inspire a more centralized and total ecological model that uses multiple modalities of information (visual, temperature, humidity), which can inform an algorithmic "concept of earth" and of healthy ecosystem flow. "Ecobiased" algorithms are a speculative idea that shifts the focus of deep learning algorithms toward Earth-centeredness. Algorithms could be applied less to human-centered profiling and toward the understanding, protection and communion with the earth ecologies for which there are many rich modalities of information that haven't yet been put together into one.

Why should our technology be informationally siloed when we, as the human species on this planet, never are and could not survive alone? The piece calls on us to acknowledge our shared spatial relations with other species as a kind of living communication network already. If every space in which signals are exchanged between organisms, be it through the air, light, temperature or vibrations, represents communication in a living spatial network, how can we rethink our technologies to be responsive to these signals and, especially, to further the surface areas of biodiversity for all living things?

References and Notes


7 Jussi Parikka, The Anthrobscene (Minneapolis: University of Minnesota Press, 2014).


20 Parikka [8].

21 Wildcat et al. [3].


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COLOR PLATE A: EARTH-CENTERED COMMUNICATION TECHNOLOGY: LIKEN AS A MODEL INTERFACE

“Water Is Earth’s Technology,” video animation, 2019. (© Julia Litman-Cleper)
Still image from Deep Learning from the Land. (See the article in this issue by Jules Litman-Cleper.)