



Self-

Similar

Communication
Between Species

Janneane Blevins

*For James who sparks new wonder in
this world, and Willa for a life of joy
and abundance.*

Self-Similar:

Communication Between Species

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Self-Similar: Communication Between Species

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A thesis submitted in
partial fulfillment of
the requirements for
the degree of

Master of Fine Arts,
Communications
Design
School of Design
Pratt Institute
May 2023

A brief prefatory note

As I was writing this paper, a new round of scientific research was published, questioning whether trees really could communicate.¹ The study was in response to forestry scientist Suzanne Simard's 1997 paper that an underground mycorrhizal network connects trees and facilitates the exchange of nutrients, resources, and information, a phenomenon dubbed the "wood wide web." She received pushback from the scientific community which bristled at her use of the term "communication" to describe this vegetal behavior. Simard, who was rigorous in her studies and scientific objectivity, had made a conscious word choice, though, that would invite humans to relate, to listen, and to ultimately start caring for trees as the living beings they are rather than as objects.²

Simard's continuing research has expanded on the initial concept of the underground network, revealing relationships between kin, cooperation between species, and the rich possibilities that perhaps these trees might even perceive us, humans. Her work has captured the public's hearts and minds — inspiring books, movies, TV shows, and how we teach our future generations. Ironically it's this excitement that has scientists worried.³

What's most interesting about this recent occurrence is not the results or that scientists have reopened the line of inquiry. What's interesting is the reflexive nature of this inquiry — what does it say about us as humans? What motivates these inquiries? To prove or disprove? What can we gain or lose by proving that trees (*and other life*) can communicate?

What Simard and subsequent scientists have exposed in this theory of communication is: 1) the possibility of cooperation and mutual aid between species; it's not pure competition or simply the survival of the fittest; and 2) intelligence, awareness, and language are not exclusively human characteristics.

These are questions of our worldview and beliefs and run contrary to capitalist hegemony and our human-centered paradigm. Our way of systematizing the world (*e.g., understanding, exploring, and even helping*) is in crisis, causing a warming earth and vanishing ecosystems. The more extensive conversation is, are we ready as humans to let go of our uniqueness? Our exceptionality? To de-center ourselves and give the planet a chance to recuperate?

My exploration of these questions forms the basis of this book, grouped into four sections that guide the inquiry. *Around*: is about awareness of self and others and a curiosity for patterns that comprise our world. *Under*: A look below the surface, below the ground, an appreciation for complexity. *Over*: A pitch and perspective shift to things that are overhead, a realization/recognition of ways to organize the planet other than from a human point of view. *Through*: is about permeation — an intermingling of world-views, perspectives, and systems.

¹Popkin, Gabriel. "Are Trees Talking Underground? For Scientists, It's in Dispute." *The New York Times*, November 7, 2022. <https://www.nytimes.com/2022/11/07/science/trees-fungi-talking.html>.

²Toomey, Diane. "Exploring How and Why Trees 'Talk' to Each Other," Yale E360 (Yale School of the Environment, September 1, 2016), https://e360.yale.edu/features/exploring_how_and_why_trees_talk_to_each_other.

³Popkin. Tree communication has been featured in the Pulitzer prize-winning novel *The Overstory*, and the highest-grossing movie of all time, *Avatar*, amongst other media.

How Might a Tree Write a Sentence?

Humans use a variety of languages to communicate with each other — from the words we speak, the text we write, the signs we read, our waves to say hi, and our smiles when we're happy. But language — both verbal and nonverbal — isn't exclusive to humans. Plants and animals also communicate with each other, using their bodies, voices, and other means and modes unseen by us — scents, chemicals, colors, and underground networks. This thesis investigates our relationship to nature and asks us to reconsider language and communication as human-exclusive systems.

Life needs other life to support it — which drives communication between creatures and species, resulting in beautiful, overlapping sensory systems of exchange. Living things, human and

nonhuman, exist in social and *sympoietic* or collectively-producing systems.⁴ However, the climate crisis and capitalism threaten these systems, disrupting the exchange and silencing the transmissions. We are experiencing an urgency to connect with the living world (*before it's too late*), to recuperate and imagine new possibilities and new futures. Futures of joy and abundance (*rather than fear and scarcity*).⁵ Futures that don't evade responsibilities, but in Haraway's parlance — stay with the trouble.⁶ These crises prompt us to ask — what can we learn from other species? How can we decenter ourselves and listen? Is it possible to open up agency without abdicating human responsibility in the present climate crisis?⁷ Can we shift from a human-centered way of knowing to a planet-centered one? *How is the climate crisis a communications crisis?*

In many ways, these questions and this search, while speculative and future-looking, bring past and present indigenous worldviews back into focus. Specifically Indigenous frameworks that valued interdependent systems and respected lands, plants, and animals and the vital energy flows connecting them.⁸

Humans are again in the middle of a paradigm shift regarding our relationship with plants. In the 1970s, it was culturally popular to imagine plants as people — albeit more eccentrically than substantially. John Baldessari parodied conceptual

⁴Haraway, Donna Jeanne. *Staying with the Trouble: Making Kin in the Chthulucene*, 58-98. Durham: Duke University Press, 2016.

⁵Tolentino, Jia. "Karen O Has Found a More Joyful Kind of Wildness." *The New Yorker*, September 11, 2022. <https://www.newyorker.com/culture/the-new-yorker-interview/karen-o-has-found-a-more-joyful-kind-of-wildness>. "It's personal, too, of course. As a parent, just like all the other parents, I'm thinking about what our children are going to inherit—how this is not the distant future, how it's happening in real time... But what makes the songs work for me is that they were written in a spirit of joy, and a desire for transcendence. Not to escape the situation but to let it out, to express it."



Image: An expression of joy in this still from *My Neighbor Totoro*, Studio Ghibli 1988.

⁶Haraway, 1-3.

⁷Malm, Andreas. *The Progress of This Storm: Nature and Society in a Warming World*. London: Verso, 2020.

⁸Valdivia, Gustavo. "Vibrant Andes in the Anthropocene." In: Blevins, Janneane; Blevins, Willa Benjamin; Hyatt, Stuart (eds.), *Stations: Listening to the Deep Earth*. Jap Sam, 2022.



Image: Baldessari, John, *Teaching a Plant the Alphabet*, 1972, Smithsonian American Art Museum

⁹ Castro, Teresa. "The 1970s Plant Craze." *Antennae: The Journal of Nature in Visual Culture*, No. 52, Sept. 2020, p. 173.

¹⁰ Pollan, Michael. "The Intelligent Plant." *The New Yorker*, December 16, 2013. <https://www.newyorker.com/magazine/2013/12/23/the-intelligent-plant>.

¹¹ Stafford, Barbara Maria, "The visualization of knowledge from the Enlightenment to postmodernism." 1994. On design's role to visualize: "No longer defined as subjugated illustrations, or just more efficient conveyors of extant verbal information, images would be recognized as free agents indispensable in discovering that which could not otherwise be known."

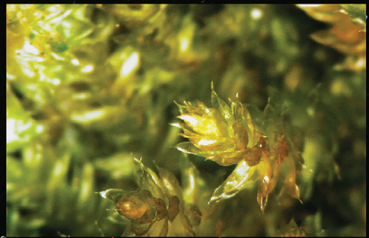
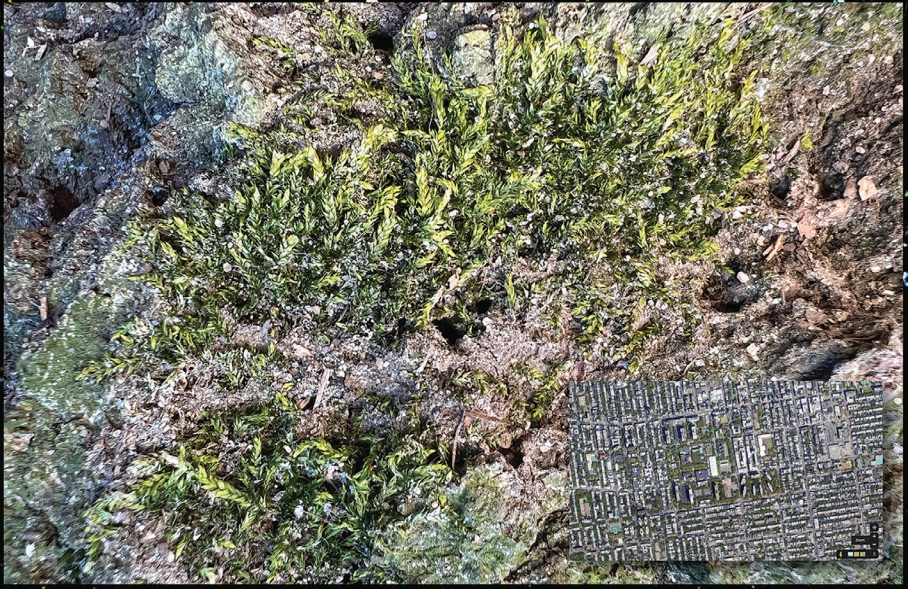
art in *Teaching a Plant the Alphabet*. Peter Tompkins' book, *Secret Life of Plants*, popularized the concept and idea of plant intelligence, but in the end, it faded into the realm of pseudo-science.⁹ This time, however, scientists, artists, anthropologists, and critical theorists are approaching the subject with renewed rigor, objectivity, reputability, and technology.¹⁰ There's an opportunity for designers to join this cross-disciplinary conversation to help visualize, connect, relate, and communicate; to make visible the invisible; to de-center human communication (*e.g., to critique extractive human-centric communication and its material effects*).¹¹

Looking to the resilient life forms of plants and fungi that have adapted to and endured environmental evolutions, seismic shifts, catastrophic climate crises, mass extinctions, and geological epochs, we ask our planetary cohabitants to inform our survival on this planet.

How might humans remember or learn from other species' ways of knowing? And can we all (*humans, plants, and animals*) communicate with each other? How might a plant tell us about the weather? Or a bee share their joy? Or a tree write a sentence? Do our languages share patterns?

Image (right): *Slow Scan Transmissions* exploration, Fall 2022. Large format vellum poster photographed with the trees that inspired the work.





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Project: *Moss Bound*, Spring 2022

How might we tell a story to moss? How might moss tell a story to us? Text offers a way of sharing histories and narratives, passing them from one to another. *Moss Bound* (Image: left) imagines a material method through which we can tell and receive these stories.

Reading with moss is a way of considering rhythm, sequence, and time. A physical rebinding and reforming of the *Iliad* through the use of seven threads, mirroring Homer's rupturous and rapturous seven-beat rhythm, mapping the occasion of seven words shared by moss and human: time, place, earth, rock, dissolve, together, flow. The cords thread the book, gathering and binding the text, obscuring some pages, and displaying others. Together with moss, an alternative reading, history, and marking of time are made possible.



Project: *Moss Cosmos*, Spring 2022

Spend a week observing moss, and your whole vision changes. Your eyes dart to the cracks, the corners, the seams — the moss knitting the tree to the earth, binding the city to the ground. Look closer, and it's not just one moss holding everything together, but many different kinds, their rhizoids intertwined, with bits of the world woven in. A single hair, a piece of lint, crumbs, a drop of dew. One small patch contains a whole universe.

Moss Cosmos (Image: p 8–9) is a poster juxtaposing macro and microscopic images of moss with screenshots from Google Maps, scaling from street to space views.

Ways of Seeing and Being

This thesis examines the communication systems of other species, searching for patterns and processes to open up and propose new frameworks for humans to interact with fellow life forms on our planet. Humans aren't exceptional in our ability to communicate, but searching for patterns and intelligence is foundationally human.¹² We look for codes, signs, and messages to connect with the world and to make it legible.

¹² Higgins, Hannah. *The Grid Book*, 273–274. Cambridge: MIT Press, 2009.

Self-Similar is a research inquiry and a body of work that illuminates this search for patterns and finds them in plants. Self-similar is a term borrowed from mathematics to describe fractals, composed of small repeating parts that scale infinitely.¹³ In this context, *Self-Similar* uses fractal frameworks to explore sociability, relationships, and communication.

Through a grounded theory approach, I'm researching data, patterns, and language in the communication of plants. Through design, these inquiries look for the interface between species — where do our systems touch and how can this inform new configurations and models for communicating, not only human-to-human, but human-to-plant and beyond.

Applying ethnographic and semiotic practices to vegetal beings, these arts of noticing reveal new considerations: new ways of being and seeing beyond the human.¹⁴ Researching through design, I have applied pattern finding and juxtaposition methods to translate the language of moss, trees, mold, and fungi into visual alphabets, glyphs, and scale-free arrangements. Complementing these visual explorations is cross-disciplinary conceptual research that I will explore throughout this paper: Suzanne Simard's wood wide web, Marvin Minsky's artificial intelligence, cybernetic and biological computing, indigenous practices of energy exchange and plant matter vitality, and paradigmatic anthropological shifts via Anna Tsing and Eduardo Kohn. Visual and conceptual explorations are grounded in communication design through Muriel Cooper's work in interface design, Marshall McLuhan's seminal work on the message, and Claude Shannon's communication theory.

Self-Similar explores nonhuman communication systems and the practice of noticing in order to open up and propose new frameworks for humans to interact with fellow life forms on earth. The goal is not to *restore* nature but, in Haraway's framing, to recuperate it: to imagine new possibilities for living on earth together.¹⁵

¹³ Caldarelli, Guido. *Scale-Free Networks: Complex Webs in Nature and Technology*, Oxford University Press, Incorporated, 2007. ProQuest Ebook Central, <http://ebookcentral.proquest.com/lib/pratt/detail.action?docId=415743>, 62.

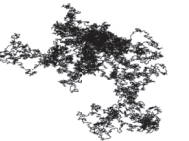


Image: Caldarelli, 84. An example of fractal growth illustrated by a random walk of one million steps. One portion of the walk as the same complexity of the whole.

¹⁴ Tsing, Anna Lowenhaupt. *The Mushroom at the End of the World: On the Possibility of Life in Capitalist Ruins*, 17–26. Princeton, NJ: Princeton University Press, 2015. Arts of noticing further defined on p 16.

¹⁵ Haraway, 101.

Intelligent Beings and Adaptive Systems

¹⁶ Higgins, 273–274. The author also quotes Theoretical physicist and neuropsychologist David Bohm: “Intelligence does not arise primarily out of thought... the deep source of intelligence is the unknown and indefinable totality from which all perception originates.”

[O]ne might conjecture that perception is an expression of this Universal Intelligence — one that is foundational to the human mind and that predetermines human experience of the world. ¹⁶

Before we can communicate, we must first become aware — of ourselves and others. When humans explore the unknown — space, deep earth, the ocean, new lands — the first thing we look for is life, specifically, intelligent life. Part of this search for intelligence is a search for familiar structures, systems, and signs.

Historically, humans built this search on finding life that looks and acts human. The idea of otherness bore portrayals of beasts, dark matter, chaos, and wildness. We approached life and land as materials that must be shaped, smoothed, or bent into our human framework. This rational ontology operates with a Cartesian divide in which there are humans and nature.¹⁷ A dualism that puts us at odds with nature and its inhabitants rather than recognizing our interdependence and shared materiality. Anna Tsing critiques this divide in her excellent book, *The Mushroom at the End of the World*:

Imagining the human since the rise of capitalism entangles us with the idea of progress and with the spread of techniques of alienation that turn both humans and other beings into resources. Such techniques have segregated humans and policed identities, obscuring collaborative survival.¹⁸

Humans are suspicious of “others” that question our notions of hierarchy and contest our essentialism. Vanessa Lemm, a known for her work on Foucault, asks: if the Enlightenment project “continuously seeks to transgress the boundaries of the human,” and “posthumanism is inscribed in this project,” then what happens when we further challenge these boundaries with plants?¹⁹ In this instance, the enlightenment is a vegetal one and an awakening from our plant blindness. In her critique, Lemm challenges us not to think of plants as animals but to address them on their terms. Plants cannot be separated from their environment — they are rooted in the ground — which troubles our ideas of autonomy. However, these conditions provide a framework of co-dependence and the collective. Plants necessarily cooperate with their environment.

Tsing explores the shifting assemblages that allow humans and non-humans to survive in precarious environments. She begins by inviting us into her practice: the “arts of noticing.” Noticing is the habit of observing life and material around you to sense ways of ordering, assembling, and cooperating. Tsing explains the motivation for the practice as follows:

As long as we imagine that humans are made through progress, nonhumans are stuck with this imaginative framework, too. Progress is a forward march, drawing other kinds of time into its rhythms. Without that driving beat, we might notice other temporal patterns. Each living thing remakes the world through seasonal pulses of growth, lifetime reproductive patterns, and geographies of expansion.²⁰

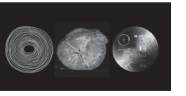


Image: Julia Christenson, *The Tree of Life*, video still, 2019.

¹⁷ Malm, 179.

¹⁸ Tsing, 19.

¹⁹ Lemm, Vanessa. “Post-humanism and Plant Studies.” NSSR lecture 11 November 2021.

²⁰ Tsing, 21.

With Lemm’s invitation to consider plants on their terms, and Tsing’s practice of noting in mind, we return to the question of intelligence. It matters how we define terms. So what is intelligence? How does the mind work? For a human, and then for a plant? In Marvin Minsky’s seminal text, *The Society of Mind*, natural intelligence can be described as follows:

I’ll call the “Society of Mind” this scheme in which each mind is made of many smaller processes. These we’ll call agents. Each mental agent by itself can only do some simple thing that needs no mind or thought at all. Yet when we join these agents in societies—in certain very special ways—this leads to true intelligence.²¹

²¹ Minsky, Marvin Lee. *The Society of Mind*, 17. Simon & Schuster, New York, 2007.

²² Ryan, John C., Patricia Vieira, Monica Gagliano, and Richard Karban. “The Language of Plant Communication (and How It Compares to Animal Communication).” Essay. In *The Language of Plants: Science, Philosophy, Literature*. Minneapolis: University of Minnesota press, 2017.

²³ Simard, S.W., Martin, K., Vyse, A., and Larson, B. (2013). *Meta-networks of fungi, fauna and flora as agents of complex adaptive systems*, Chapter 7, 133.

²⁴ Minsky, 17.

Intelligence links smaller units, processes, and automation into adaptive systems. Richard Karban describes this same framework in plants: “Plants are made up of repeated units, many of which are capable of sensing stimuli, acquiring resources, becoming reproductive organs, and any number of other functions that are performed solely by specialized organs in animals.”²² In this way, a self-contained plant has an intelligence that allows it to sense and acquire information from its environment. Plants, linking together with kin, multiply these shared interactions resulting in a deepened collective knowledge.

In subsequent studies, Simard describes how fungi and plants can be “agents of self-organization because they provide avenues for cross-scale interactions and feedback, from which emerge structure and function in complex adaptive systems.”²³ For Minsky, this complexity and cross-connecting is “the nature of the mind: much of its power seems to stem from just the messy ways its agents cross-connect.”²⁴

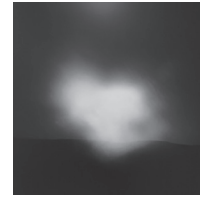
Words Make Worlds

2

Language — a system of symbols, spoken, signed, and written — is defined as a unique system to humans.²⁵ Language also reveals how we chart relationships with each other.²⁶ As we look at the interaction of other species, previous paradigms, and alternate worldviews, the definition of language begins to expand beyond the human.

²⁵ "Language." *Encyclopedia Britannica*. Accessed November 9, 2022. <https://www.britannica.com/topic/language>.

²⁶ Kimmerer, Robin Wall, *Braiding Sweetgrass*, 57, Milkweed Editions, Minneapolis, 2013.

²⁷ Kimmerer, 56²⁸ Kimmerer, 56–57.²⁹ Valdivia, 22Image: Oscar Santillán. *Solaris*. 2017³⁰ Santillán, Oscar. “Interfaces for the Earthverse.” Afro and Indigenous Futures lecture 24 March 2022.³¹ Malm, 183–184. Malm references ideas from Carolyn Merchant’s *The Death of Nature: Women, Ecology and the Scientific Revolution*.³² Haraway, 12.

Robin Wall Kimmerer, scientist, botanist, and 2022 MacArthur Fellow, discusses the importance of a grammar of animacy, to supersede the English language divisions of *human* or *thing*.²⁷ For example, the Potawatomi language grants animacy to plants, animals, and even “rocks are animate, as are mountains and water and fire and places. Beings that are imbued with spirit... even stories are all animate.”²⁸ There are different ways to be animate than to be human. Kimmerer and her students reason that projecting only our human ways of seeing anthropomorphizes nonhumans and ignores their ways of living.

Anthropologist Gustavo Valdivia examines the *wak’as* of pre-Hispanic Peru, in which vital force “circulates reciprocally among human and nonhuman beings...a world in which places and people formed part of a larger, interdependent, and animated collective.”²⁹ The ontology continues into the work of artist Oscar Santillán, informed by the ancient Andeans’ regard for a mountain as an *earthbeing* — emanating cognitive capabilities and materiality. Santillán is currently investigating “decentralized cognition’... an interface capable of connecting A.I., ecological systems, and humans.”³⁰

Kimmerer’s grammar of animacy illustrates that the English linguistic worldview, which makes everything nonhuman an object, dictates a construct in which “living land” becomes a “natural resource.” Creatures, plants, and land are suddenly at our disposal to be used, extracted, and exhausted.

Human ecologist Andreas Malm analyzes humans’ relationship with nature in *The Progress of This Storm*. Malm recounted the “epochal transition” when capitalist seeds took hold in fourteenth-century Europe — wetlands were drained, fields enclosed, and forests cut down. Humans’ perception of nature shifted from that of an organic living being to be revered and respected to a nature that was dead with inert resources to be owned and mastered.³¹

In the twenty-first century, humans are reconsidering how we relate to nature. In *Staying with the Trouble*, Donna Haraway refuses human exceptionalism and speaks to an ongoing “becoming-with” of companion species through her practice of *sympoiesis* and multispecies storytelling. Haraway embraces the contingencies, relations, and messy ways companion species come together.

It matters what matters we use to think other matters with; it matters what stories we tell other stories with; it matters what knots knot knots, what thoughts think thoughts, what descriptions describe descriptions, what ties tie ties. It matters what stories make worlds, what worlds make stories.³²

Artist Jenna Sutela works with words, sounds, and “living media” (bacteria and molds). In her 2018 work, *nimiia cetii*, she used AI and audio to ‘mediate’ the movement of bacteria, making the forms of a speculative language. Her work draws attention to the precarity of relationships, particularly when it comes to technology:

In the words of Madeline Gins and Arakawa: “[...] we must [...] forget ‘language,’ all those mechanisms that structure ‘us’ vis-a-vis the

‘world,’ and so stutter our way to divinity.” I think interspecies translation is difficult, even impossible. We need to try and move beyond language in our communications with different life forms. And we also need to finally move from traditional ideas of agency as an exclusively or predominantly human attribute to a concept where human agency is bound up with that of bacteria, viruses, etc. Also machines. My friend K Allado-McDowell recently wrote the book *Pharmako-AI* together with OpenAI’s neural net language model GPT-3. They describe the writing process as experimentation with a language ecology that’s not limited to human meaning.³³

How might we move beyond language? What are other systems that mediate our relationships with each other, nonhumans, and the planet?

Image: Jenna Sutela *nimiia cetii*, 2018, video still³³ Blidaru, Adriana. “Living Content 48. Interview with Jenna Sutela.” Living Content, March 12, 2021. <https://www.livingcontent.online/interviews/jenna-sutela>.

The Language of Geometry and Patterns

Cognitive neuroscientist Stanislas Dehaene posits that our capacity for geometry is more essential to humans than language:

We are proposing that there are languages — multiple languages — and that, in fact, language may not have started as a communication device, but really as a representation device, the ability to represent facts about the outside world.³⁴

³⁴ Roberts, Siobhan. “Is Geometry a Language That Only Humans Know?” *The New York Times*, March 22, 2022. <https://www.nytimes.com/2022/03/22/science/geometry-math-brain-primates.html>.

Dehaene argues that since humans first emerged, we have had the unique capacity to imagine — to mark our environments with depictions of spirals, triangles, and dots, and to develop tools that helped us do this, like the bi-face or cuneiform stylus. These marks helped humans to process and represent what was happening in the world around them. Dehaene’s study compares humans with baboons and employs AI neural networks to try to understand this geometric conceptual program with which humans are “loaded.”

As infants and children, our toys and learning environments are populated with circles, triangles, and squares — geometric shapes that provide early building blocks for learning math, language, relationships, and size. The Latin alphabet is composed of shapes — abstracted fragments that string together like beads to construct meaning.³⁵ But this Euclidean smoothing and simplifying of our environment might override our early human preferences for more complex and fractal patterns. In a 2020 study published in *Nature*, researchers found that rather than our appreciation for complexity increasing with age, a child has the same preferences for complexity as an adult.³⁶ As the study concludes:

This leaves open the possibility that an early biological or evolutionary mechanism optimizes the visual system for processing fractals — the most common spatial structure (of low–moderate complexity) found in nature (Falk and Balling, 2010), supporting a universal Fractal Fluency theory.³⁷

In their ongoing series of *Ligature Drawings*, Tauba Auerbach reconsiders the form of our written language. Bold, snaking, continuous gestures on graph paper present paragraphs as a single stroke. The near-typography is produced through a “kind of automatic writing stripped of linguistic meaning; the curves themselves are the content.”³⁸ The Clark Art Institute recently exhibited Auerbach’s meandering lines, in which the ligatures were contextualized as such:

...these lines wind their way through human history and the natural world: known as meanders, frets, or keys, they appear in diverse ornamental traditions (ancient Mediterranean, Mesoamerican, and East Asian among them) but also as waveforms in physics, space-filling curves in geometry, and the helices of our DNA. Auerbach traces and transforms these lines in multiple dimensions; if they resonate with us, the artist believes, it might be at a fundamental, even cellular level.³⁹

Might we reason that while geometry connects us to other humans, fractals could connect us with non-humans? If patterns are found, not invented, then humans, not separate from nature, but part of and from nature, search for these patterns in the world to find themselves. Can we have languages that run in parallel or operate multi-dimensionally? Those that are fractal and those that are abstract? Those of humans and non-humans?

³⁵ McLuhan, Marshall, Jerome Agel, and Quentin Fiore. *The Medium Is the Massage*. London: Penguin Books, 2008.

³⁶ O Robles, Kelly E., Nicole A. Liaw, Richard P. Taylor, Dare A. Baldwin, and Margaret E. Sereno. “A Shared Fractal Aesthetic across Development.” *Humanities and Social Sciences Communications* 7, no. 1 (2020), 7. <https://doi.org/10.1057/s41599-020-00648-y>

³⁷ Robles, 7.

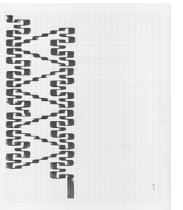


Image: Tauba Auerbach, *Ligature Drawings*, 2022.

³⁸ Wiesenberger, Robert. “Meander: Tauba Auerbach and Yuji Agematsu.” The Clark Art Institute. The Clark Art Institute, July 16, 2022. <https://www.clarkart.edu/microsites/meander/tauba-auerbach/about-the-work>.

³⁹ Wiesenberger, “Meander.”



Project: *Bloom*, Fall 2021

I created a material study (Image: p 24–25) of my own breast milk with the idea that the milk is food and contains food. In these studies, the food from which the milk originated is now blooming in it, both microscopically and very visibly. These material studies glitched the ritual of making milk, feeding, eating — a process repeated many times daily, over and over. Repetition with variation, purposefully confusing the directionality of cause/effect in order to make it both at once.

These material studies were translated into paper weavings (Image: p 23). Displayed as a mobile, the weavings reflect the nature of blooming, overlapping without obscuring each other. *Bloom* expresses language as a fabric, compressing it, so it can coexist in the same place, at the same time — or in a different place at a different time.

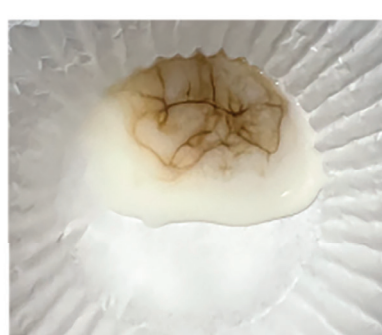
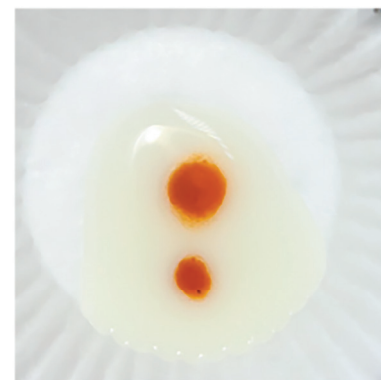
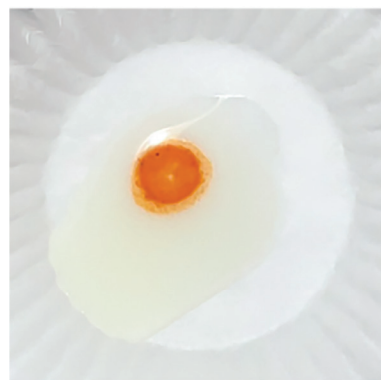
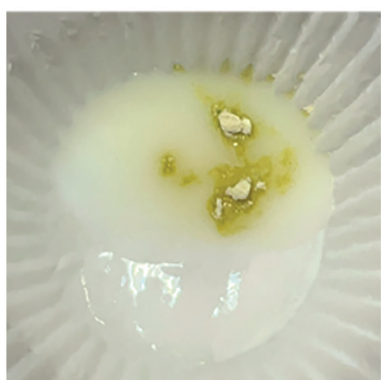
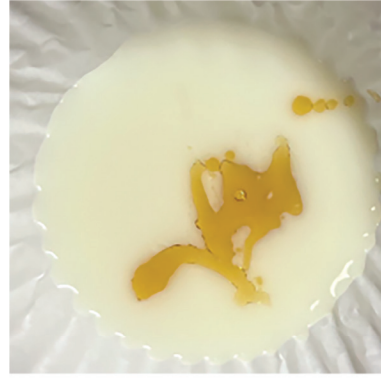
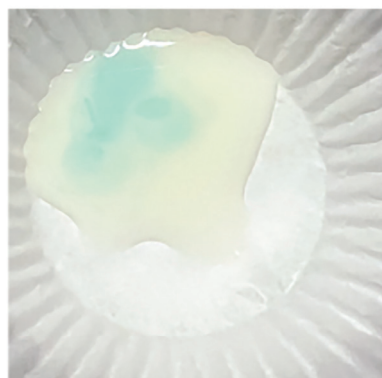
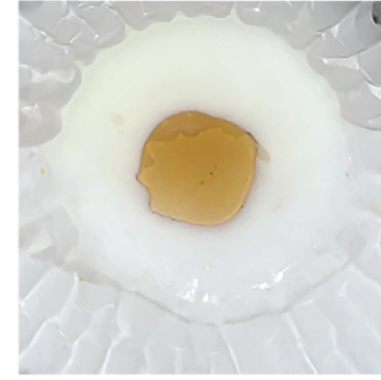
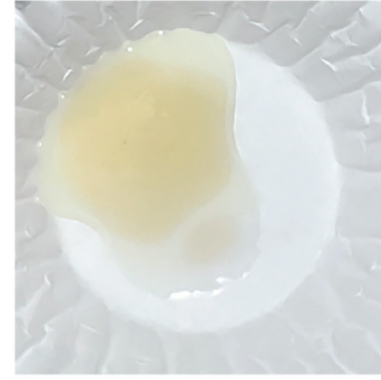
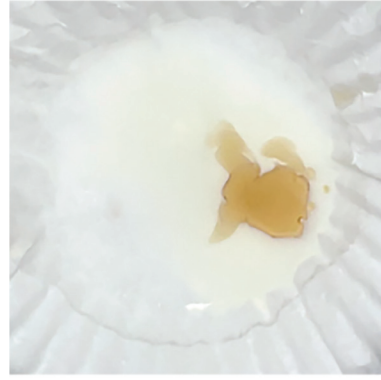
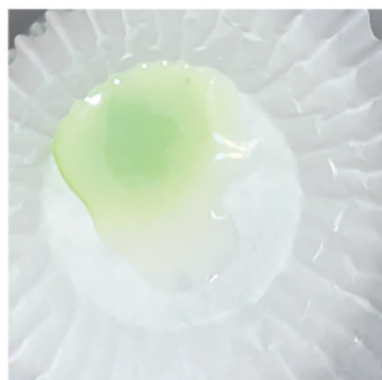
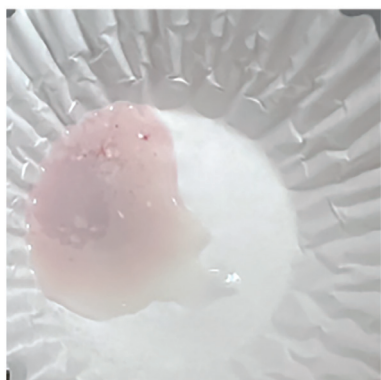
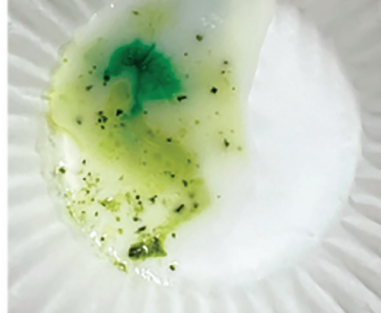
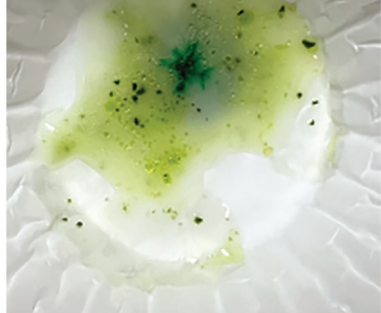


Image (below): Mycelium shape sorter, Spring 2022. Reimagining a childhood toy through biomaterials.

Ways of Organizing: Grid and Fractal



Evolving in step with human geometry and early language was the use of the grid. Hannah Higgins’s excellent text, *The Grid Book*, traces the stamp of the grid from early to modern human uses to terraform, build, map, note, transact, communicate, perceive, and network our world.⁴⁰ The grid helped organize (*and survive*) chaos (*i.e., nature*), carving it into orderly units that could be built, counted, and traded.⁴¹

⁴⁰ Higgins, Hannah. *The Grid Book*. Cambridge: MIT Press, 2009.

⁴¹ Lippert, Angelina. “The Swiss Grid.” Poster House. Poster House, January 7, 2022. <https://posterhouse.org/exhibition/the-swiss-grid/>. The grid is commonplace in design, a necessity of the printing press, and an essential framework of the 1950s Swiss Style, which favored streamlined geometric compositions, sans-serif type, and “instantly comprehensible designs.”

Perhaps what's most exciting about Higgins's text is her section, "Towards Fractal Dimensions," in which she proposes a shift from the world of the linear grid to one of fractals. Higgins demonstrates how this way of receiving the world is commensurate with an ancient way of knowing:

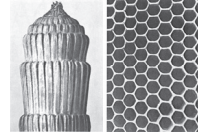


Image: (Left) detail of a horsetail plant and (right) honeycomb from Müller-Brockmann, Josef. *Grid Systems in Graphic Design*. Sulgen: Niggli, 2012.

⁴² Higgins, 271.

⁴³ Higgins, 268.

To illustrate the idea of fractal dimensions, Higgins asks us to consider a line. First, a line is composed of infinite points that blend to form a solid line. Second, from a fractal framework, these points consist of an infinite number of smaller points with spaces between them.⁴³

Fractals, though not regular and "rational," like the perpendicular lines of a grid, do provide organizing principles of self-resembling and self-similarity that can help us make sense of the world. Because of these properties, they behave according to a set of rules, "albeit one that is regularly irregular, or predictably unpredictable."⁴⁴ Higgins quotes from Mandelbrot:

⁴⁴ Higgins, 270.

The geometry of this self-resembling is not, however, regular in the Euclidean sense. Mandelbrot wrote that "clouds are not spheres, mountains are not cones, coastlines are not circles, and bark is not smooth, nor does lightning travel in a straight line," a description that pits him against the geometric world view... "The most useful fractals involve chance, and both their regularities and their irregularities are statistical."⁴⁵

What's exciting about fractal dimensions is that they allow for scaling. Parts have similar properties to the whole. This scaling enabled NASA scientists to make models of the vast cosmos using slime mold. Observing the near-optimal pathways that slime mold builds between food sources revealed an uncanny resemblance to the cosmic web. Scientists on the project remarked:

⁴⁵ Higgins, 270. Higgins also explores the concept of chance as it relates to the Fluxus art movement, of which her parents, Dick Higgins and Alison Knowles were members.

"It's really fascinating that one of the simplest forms of life actually enables insight into the very largest-scale structures in the universe," said lead researcher Joseph Burchett of the University of California (UC), Santa Cruz. "By using the slime-mold simulation to find the location of the cosmic web filaments, including those far from galaxies, we could then use

the Hubble Space Telescope's archival data to detect and determine the density of the cool gas on the very outskirts of those invisible filaments. Scientists have detected signatures of this gas for several decades, and we have proven the theoretical expectation that this gas comprises the cosmic web."⁴⁶

The art collective Cesar & Lois were similarly inspired by the networked intelligence of slime mold and collaborated with the organism to invite ways of non-anthropocentric thinking. In a series of artworks, they challenge human-centered systems and propose "microbiological frameworks" to build networks with "ecosystemic intelligence."⁴⁷ These networks offer connections across human, non-human, and artificial intelligences.

In the 1950s and 60s, Stafford Beer and Gordon Pask, cybernetic pioneers, investigated the possibilities of biological computing, such as a factory run by a pond. The speculative pond-computer had self-organizing and self-regulating properties that would allow it to adapt and regulate.⁴⁸

Regulation is a function of disturbance — a natural phenomenon that "opens the terrain for transformative encounters, making new landscape assemblages possible."⁴⁹ However, our human systems and actions have exacerbated environmental disturbances (e.g., forest fires) to catastrophic consequences. Capitalism knows no limits, and the warming world is nature's response. Malm says this, borrowing from E. Ann Kaplan: "nature is now offering instructions to humankind by its very violent intrusions."⁵⁰

How do we get back to transformative encounters and imagining new landscape assemblages? Could a fractal way of receiving the world knit us together with nature instead of against it? What happens when our communication systems are based on ecosystemic intelligences?

⁴⁶ Garner, Rob. "Slime Mold Simulations Map Dark Matter Holding Universe Together." NASA. NASA, March 10, 2020. <https://www.nasa.gov/feature/goddard/2020/slime-mold-simulations-used-to-map-dark-matter-holding-universe-together>.

⁴⁷ G Solomon, Lucy HG, Cesar Baio, and Cesar & Lois. "When Do We Stop Being Human? Prefiguring Nonanthropocentric Thinking." *Leonardo* 55, no. 5 (2022): 445–50. https://doi.org/10.1162/leon_a_02246.

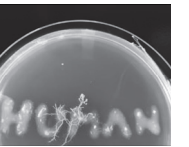


Image: Workshop output, growth of *Physarum polycephalum* layered with text as part of A Collaborative Writing Workshop with Nonhuman Entities, Cesar & Lois, Coalesce Center for Biological Arts, University at Buffalo, NY, 2020.

⁴⁸ Pickering, Andrew. "Beyond Design: Cybernetics, Biological Computers and Hylozoism." *Synthese* 168, no. 3 (2008): 469–91. <https://doi.org/10.1007/s11229-008-9446-z>.

⁴⁹ Tsing, 160.

⁵⁰ Malm, 77.

Many-to-Many Configurations

⁵¹ Simard, Suzanne W., et al. "Mycorrhizal Networks: Mechanisms, Ecology and Modelling." *Fungal Biology Reviews*, Vol. 26, No. 1, Apr. 2012, 39.

⁵² Simard, "Mycorrhizal Networks," 55.

⁵³ Bar-Yam, Yaneer. "Power Law." New England Complex Systems Institute. New England Complex Systems Institute, 2011. <https://necsi.edu/power-law>. A power-law is a mathematical, statistical term, indicating a relationship in which the change of one quantity gives rise to the proportional change of another quantity. Power-laws are important as an indicator of regularity in systems, and particularly helpful when analyzing complex systems. Many natural and human systems follow power-laws.

Beneath our feet lies a vast network of interconnected mycelial threads transmitting messages that connect nearly every tree in the forest, the grasses of a prairie, arctic tundra, and savannah. Theoretically, wherever there are two plants, there's the possibility for subterranean fungal networks facilitating their communication.⁵¹ This multispecies mycorrhizal network is resilient, self-reinforcing, and scale-free due to its critical fractal structure.⁵² This topology operates according to a power law, where large hubs accumulate new connections.⁵³

The revelation of this ancient proto-internet came to the fore in 1997 in the aforementioned study by Suzanne Simard — right around the same time that our human internet was dialing up in homes worldwide. Simard, who was interested in why tree plantations, arranged meticulously in rows with rigorous specifications, were not faring as well as their wild counterparts, discovered an arboreal network in old-growth forests that connected many species, allowing them to connect, exchange, and signal one another.⁵⁴ In a 2020 feature in *The New York Times*, Ferris Jabr interviews Simard about the network, describing it as:

The trees, understory plants, fungi, and microbes in a forest are so thoroughly connected, communicative and codependent that some scientists have described them as superorganisms... Together, these symbiotic partners knit Earth's soils into nearly contiguous living networks of unfathomable scale and complexity.⁵⁵

Simard's continuing research with various First Nations communities in British Columbia reveals reciprocity and relationships between kin, a direct rebuttal to standard forestry practices predicated on competition and survival of the lone plant/tree, as well as the view of "nature as a resource."⁵⁶

On the podcast *Future Ecologies*, hosts Mendel Skulski and Adam Huggins explored permaculture in British Columbia in the episode "Forest Garden."⁵⁷ First Nations peoples, perhaps for millennia, cultivated patches in the forest to produce desirable food — hazelnuts, crabapples, berries, and more. It was remarkable that these permaculture practices endured centuries after the caretakers were forcibly removed from their land — enough time for the forest to re-absorb them. But due to the careful and attuned design of these patches, the biodiversity was enough that the species grew together in a metastable ecosystem. After speaking with Cha'qua'wet Willie Charlie of Sts'ailes, they summarized the concept of two-eyed seeing:

The concept of two-eyed seeing is simple enough. But in practice, most of us are so used to looking at things with a Western worldview, that it's really easy to just pay lip service to that Indigenous worldview, without actually learning how to see with it or engage with it... It takes time and attention to learn how to see things differently: to listen to what origin stories, and language, and place names, and even governance systems are actually telling us about how the world works.^{58, 59}

⁵⁴ Simard, S.W., Perry, D.A., Jones, M.D., Myrold, D.D., Durall, D.M., and Molina, R. (1997). "Net transfer of carbon between tree species with shared ectomycorrhizal fungi." *Nature*, 388: 579-582.

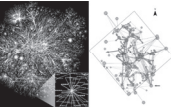


Image: (Left) Partial map of the Internet based on the January 15, 2005 data found on opte.org. (Right) Simard, S.W. Spatial topology of genes and trees from "Mycorrhizal networks."

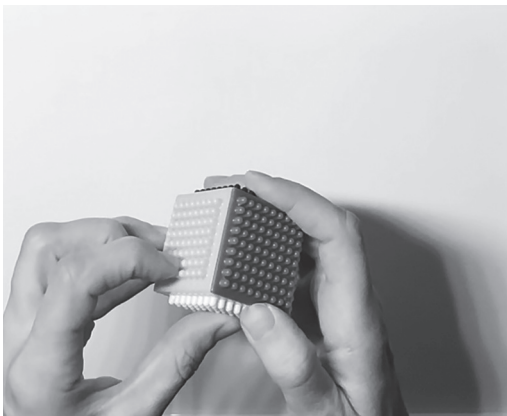
⁵⁵ Jabr, Ferris. "The Social Life of Forests." *The New York Times*, December 3, 2020.

⁵⁶ Springer, Anna-Sophie, and Etienne Turpin. *The Word for World Is Still Forest*, XVI. Berlin, Germany: K. Verlag / Haus der Kulturen der Welt, 2017.

⁵⁷ Huggins, Adam and Mendel Skulski. "4.1 - FOREST / GARDEN." Produced by Adam Huggins and Mendel Skulski. January 28, 2022. *Future Ecologies*. Podcast, 58:09. <https://www.futureecologies.net/listen/fe-4-1-forest-garden>

⁵⁸ Huggins and Skulski.

⁵⁹ Huggins and Skulski. Two-eyed seeing is "a concept put forward by Dr. Albert Marshall — a Mi'kmaw elder in Unama'ki, Cape Breton. It means allowing one eye to see with an Indigenous worldview and the other eye with a Western one."



Project: *Many to Many: An Auditory Performance of Everyday Objects*, Fall 2022

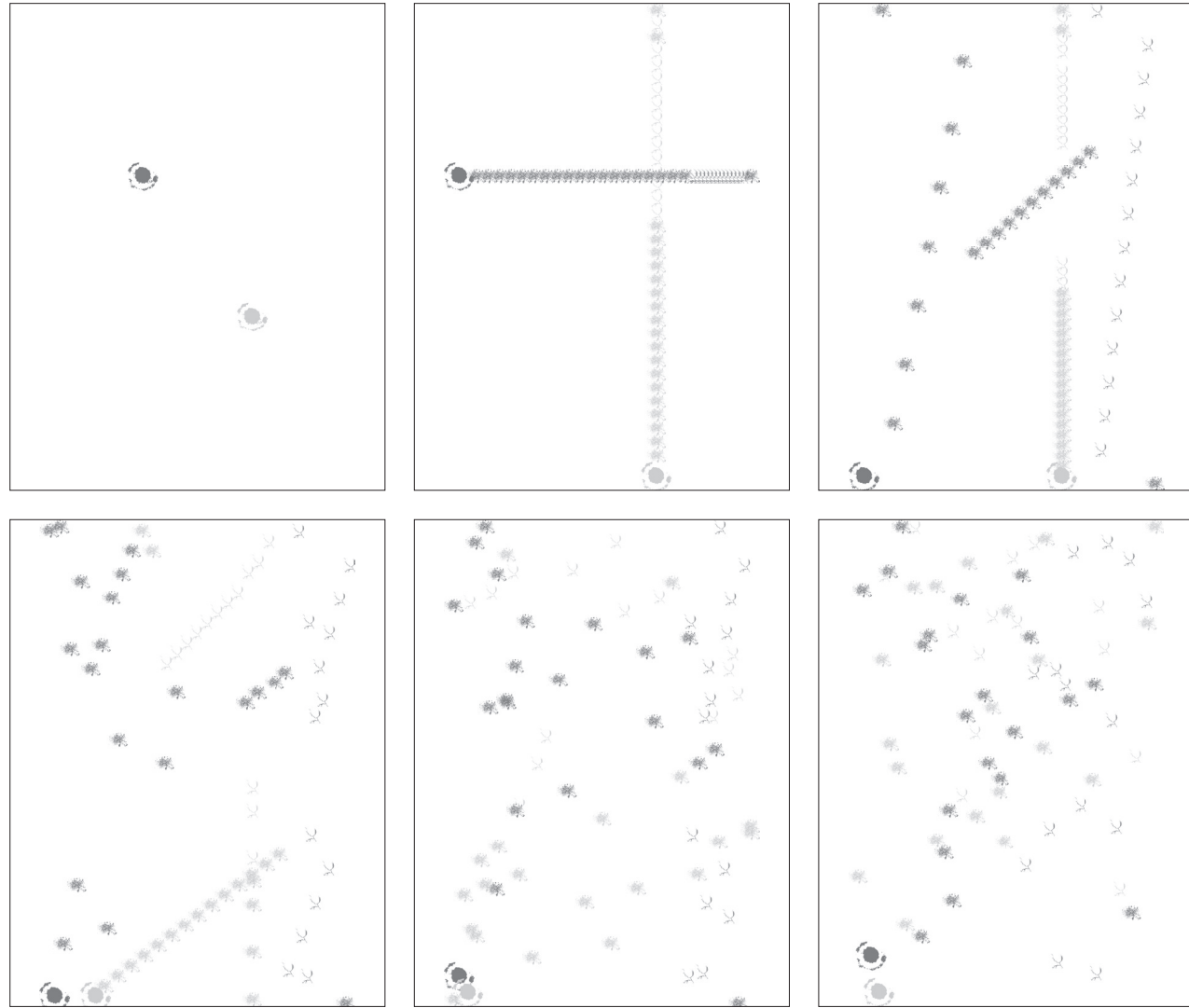
Many to Many began as a study and became a methodology for exploring the networked communication of trees. The result was a Fluxus-inspired score using everyday objects to examine the pre-verbal and sensory ways humans navigate the world. A comb, a jar of sprinkles, a set of rubber bands, one plastic block, a coffee can with a lid, a stack of Post-it notes, a toothbrush, a teaspoon, and a No. 2 pencil. These everyday objects are used in an unintended way: to make sound. A single tap, a discordant chorus, a sonorous conversation. (Images: above)

Other Beings' Ways of Seeing

3

Up to this point, this paper has largely been from the viewpoint of humans: how we see other beings. But what happens when we consider how other beings see us? When we consider that they can see, know, and perceive us?⁶⁰

⁶⁰ Jabr. "I think these trees are very perceptive," Simard said. "Very perceptive of who's growing around them. I'm really interested in whether they perceive us." I asked her to clarify what she meant. Simard explained that trees sense nearby plants and animals and alter their behavior accordingly: The gnashing mandibles of an insect might prompt the production of chemical defenses, for example. Some studies have even suggested that plant roots grow toward the sound of running water and that certain flowering plants sweeten their nectar when they detect a bee's wing beats. "Trees perceive lots of things," Simard said. "So why not us, too?"



Images: Scale-free explorations, Spring 2022. A multi-stage analysis and exploration of scale-free design using found fungal forms and rule-based alignment to disperse them in a confined space.

These are the questions anthropologist Eduardo Kohn raises in *How Forests Think*. He proposes an ontological shift that does not “do away with the human or reinscribe it but to open it.” Looking at the properties we think of as distinctively human — language, culture, society, and history — he considers how these structures might open through everyday engagements with other kinds of creatures.⁶¹ Kohn suggests humans conflate our own way of constructing language with how all languages are built; but, he proposes, signs exist beyond the human:

What we share with nonhuman living creatures, then, is not our embodiment...but the fact that we all live with and through signs... Semiosis (the creation and interpretation of signs) permeates and constitutes the living world, and it is through our partially shared semiotic propensities that multi-species relations are possible, and also analytically comprehensible.⁶²

How we communicate and the systems we use — the patterns we see and find in the world — inform our points of connection and open up a dialogue. Language is our multi-species interface!

In the book-as-exhibition, *The Word for World is Still Forest* (its title borrowed from Ursula K. Le Guin’s 1972 science fiction novella), editors Anna-Sophie Springer & Etienne Turpin pay “homage to the forest as a turbulent and generative multinature.”⁶³ The book seeks to open up a space for transformations through text, art, and typography explorations. An essay from Pedro Neves Marques about Amerindian multinaturalism is described as such:

[The essay] sharpens our sense of the forest as an ontological multiplicity teeming with relations, perspectives, and temporalities. That such forests and worlds are largely incommensurable with Eurocentric image-making technologies poses a serious challenge to understanding and solidarity by demanding that we learn “how to inhabit the space of the in-between, the interval between ‘worlds’ in order to contribute to a decolonization of the many worlds from the imposition of the ‘one world.’”⁶⁴

Might the fractal dimension offer us a chance to explore the space between? Thinking back to the definition of a line composed of infinite points that curve—could we think of these as curving out, providing alternate paths to other dimensions? What happens when we tune into these spaces? Could we find new depths? Other voices? New ways to center and organize our world?

⁶¹ Kohn, Eduardo. *How Forests Think toward an Anthropology beyond the Human*, 6. Berkeley, CA: University of California Press, 2015.

⁶² Kohn, 9.



Image: Sareen, Harpreet. Elowan / Plant-Robot Hybrid following light. 2018.

⁶³ Springer and Turpin, XIV.

⁶⁴ Springer and Turpin, XV.

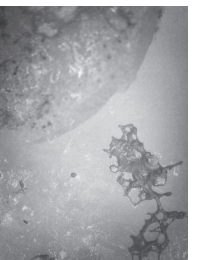


I created a set of cloth prints from these images (right), which circled back to my initial inquiry of what it means “to store.” These cloths can be used to wrap and hold items like citrus that tend to mold. These cloths are an attempt to recontextualize mold, an undesirable outcome when storing food, and form a new appreciation for its intelligence, functionality, and even beauty. Molds are foundational organisms that break down matter and return it back to their ecosystems, where it’s stored in the earth, providing nutrients for new things to grow.



Project: *Physarum Systems*, Fall 2021

Cultivating *Physarum polycephalum* was a process of chance and observation, relinquishing control and watching how another species develops systems, shares information, the patterns it creates, and the architecture it builds to do so. My microscopic documentation yielded some pretty incredible, otherworldly visuals — at once primordial and futuristic, an elastic sense of time for an organism that can carry us to the deep past and far future (Images: p 36–41). Incredibly, this organism is used by scientists to inform their search for dark matter.⁷²



Entropy, Uncertainty, and the Message

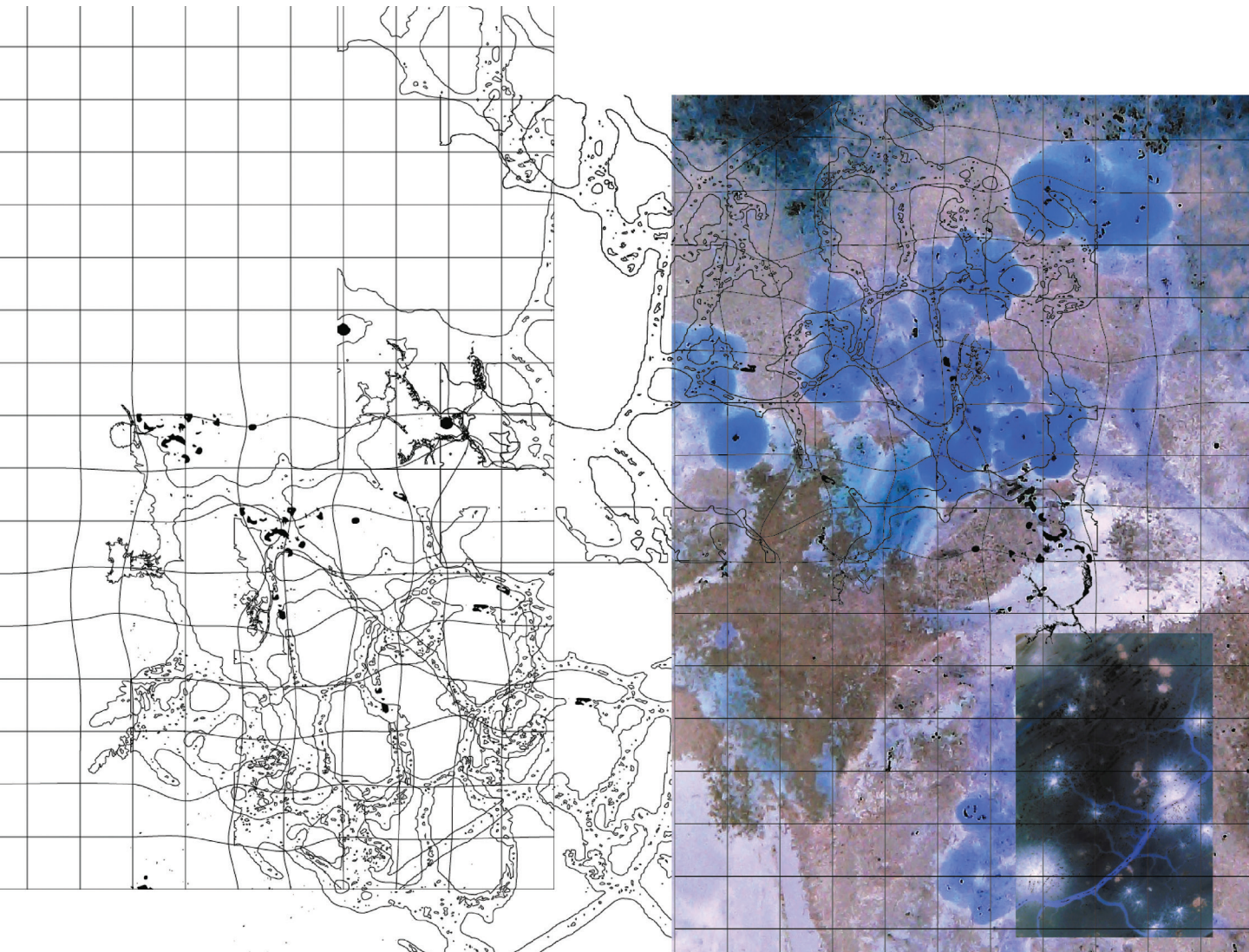


Claude Shannon's revelatory universal theory of communication from 1948 laid the groundwork for today's communication systems: how to encode communications and transmit them efficiently and accurately. His brilliance in solving this problem was the realization that communication is about uncertainty — we don't know what the other participant is going to say.

⁶⁵ Tse, David. "How Claude Shannon Invented the Future." *Quanta Magazine*, February 26, 2021. <https://www.quantamagazine.org/how-claude-shannons-information-theory-invented-the-future-20201222/>.



Image: Illustrating a paradigm shift, Spring 2022. A rigid grids yield to rhizomatic structures, non-linear paths of organization, as revealed by microscopic views of mold.



Shannon's mathematical theorem identified two key constraints: the entropy (the minimum bits to represent the message) and the capacity of the communication channel. If: a) the message is simple, b) the channel is noiseless, and c) the communication is one-way, then d) the message can be compressed optimally. As each of those factors grows, it gets harder and harder to reduce and compress the message.⁶⁵

Mark Braverman, a computer scientist and 2022 MacArthur fellow celebrated for his work with Julia set fractals,⁶⁶ might be the first scientist to add to Shannon's theory with equal brilliance. He and his colleagues are solving for the interactive compression problem, which asks:

If two people exchange a million text messages but only learn 1,000 bits of information, could the exchange be compressed to a 1,000-bit conversation instead? ...[R]esearchers have shown that the answer is a resounding no.⁶⁷

It will be exciting to see how Braverman will solve this, and the applications are interesting in the context of this paper. How can we construct communication channels that allow for more interactive conversations and complexity while maintaining the ability to read the message? What communications are valued as information? What happens when we think of nature bearing the signal and humanity the noise? Extending further, we know that the uncertainty of a message is given and solved for, but what if the language, or the code, is also unknown? In the case of interspecies communication, how do we decompress received transmissions? Is there something beyond our human language that provides this cipher?

Phenomena we don't understand are often described as random. There's proven inherent randomness in nature, most recently measured as 34% and counting.⁶⁸ This idea of randomness is stochastic chaos, allowing evolution and new possibilities to take hold. With human communication, we're constantly figuring out how to be the most accurate in the least amount of time, and our algorithms reinforce what we already know. With each round of compression, we lose the possibility of new meanings. Put another way, communication with nature has an emergent property — it can't be determined ahead of time or figured out, and the property of the whole is different from the property of the parts. The uncertainty is what allows for novel information and connections.⁶⁹ Tsing describes these fluctuations as shifting assemblages:

Nonhuman ways of being, like human ones, shift historically. For living things, species identities are a place to begin, but they are not enough: ways of being are emergent effects of encounters... If history without progress is indeterminate and multidirectional, might assemblages show us its possibilities? Patterns of unintentional coordination develop in assemblages. To notice such patterns means watching the interplay of temporal rhythms and scales in the divergent lifeways they gather.⁷⁰

⁶⁵ Houston-Edwards, Kelsey. "Mathematicians Set Numbers in Motion to Unlock Their Secrets." *Quanta Magazine*, October 26, 2021. <https://www.quantamagazine.org/mathematicians-set-numbers-in-motion-to-unlock-their-secrets-20210222/>. A Julia Set is an intricate fractal picture of a dynamic system, illustrating what happens when you plug a number into an equation again and again.

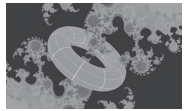


Image: Vignette, Julia Set, *Quanta Magazine*.

⁶⁷ Ornes, Stephen. "Mark Braverman Wins the IMU Abacus Medal." *Quanta Magazine*, July 5, 2022. <https://www.quantamagazine.org/mark-braverman-wins-the-imu-abacus-medal-20220705/>.

⁶⁸ Thompson, Joanna. "Hidden Chaos Found to Lurk in Ecosystems." *Quanta Magazine*, July 27, 2022. <https://www.quantamagazine.org/hidden-chaos-found-to-lurk-in-ecosystems-20220727/>.

⁶⁹ Ratti, Carlo, Daniel Carmody, Martina Mazzarello, Paolo Santi, and Timur Abbasov. "Proximate: The Effect of Co-Location on Human Communication Networks." Proximate. MIT Senseable City Lab, July 14, 2022. <http://senseable.mit.edu/proximate/>.

⁷⁰ Tsing, 23.

⁷¹Higgins, 270.

As we look for new ways of communicating with nature, is there a way to favor other qualities than efficiency? Less human-centered? *That allows us to communicate on nature's terms?* Going back to Mandelbrot, "The most useful fractals involve chance, and both their regularities and their irregularities are statistical."⁷¹

How many messages are we receiving from the tree or from plants? How do we adjust the human channel to receive the signal of others, amplify, distribute, or make it visible?

⁷² Garner, Rob. "Slime Mold Simulations Map Dark Matter Holding Universe Together." NASA. NASA, March 10, 2020. <https://www.nasa.gov/feature/goddard/2020/slime-mold-simulations-used-to-map-dark-matter-holding-universe-together>.

Slow Scan and the Space Between

MIT's Visible Language Workshop, founded in 1974 by Muriel Cooper and Ron MacNeil, was a designer's playground for experimenting with new ways of thinking about computers, technology, artificial intelligence, and design.

⁷³ Reinfurt, David, and Robert Wiesenberg. "Soft Copy." Essay. In *Muriel Cooper*, 20–21. Cambridge, MA: The MIT Press, 2017.



Image: Tom Klinkowstein (Amsterdam, The Netherlands), Aldo Tambellini (Cambridge, MA) and Bill Bartlett (Pender Island, Canada), *3 Artists On-Line On Slow-Scan-TV*, 1980.

⁷⁴ Reinfurt, 21.

⁷⁵ Reinfurt, 21.

⁷⁶ Tsing, 282. Tsing pairs latency with the commons to describe a search for the still possible. "We can still explore the overgrown verges of our blasted landscapes - the edges of capitalist discipline, scalability, and abandoned resource plantations. We can still catch the scent of the latent commons - and the elusive autumn aroma."

⁷⁷ Latency (n.). Online Etymology Dictionary, September 25, 2017. https://www.etymonline.com/word/latency#etymonline_v_30688.

They would hack existing technologies to give them new possibilities, like the Airbrush Plotter, which linked together multiple existing frameworks to form a large-scale inkjet printer and SYS, a "proto-Photoshop image-editing suite."⁷³ MIT worked with many government agencies and had access to all sorts of technology used by the military. This included Slow-scan television, a mechanism for sending and receiving images over a telephone line, which the U.S. and Soviets used to send images back and forth between earth and space. Frame by frame, a video was translated into audio waves, then into pixel values, and then reassembled one row at a time on the receiving video display.⁷⁴

In a 1980 conference, "Artists' Use of Telecommunications," participants dispersed between MIT, San Francisco, Tokyo, Vienna, Vancouver, New York, and Toronto sent images and text to one another using this slow scan technology. In "Soft Copy," David Reinfurt describes it as such:

Remotely sent images appear, almost magically, line by line on a video monitor from the top of the screen, accompanied by the wild squeal of its encoded audio data. Each image slowly erases the previously transmitted image over the course of its eight-second transmission. Assembled participants witness the received images while actively preparing for the next to be sent. At one point, Marvin Minsky of the MIT Artificial Intelligence Laboratory records a contest between a live turtle and its artificially intelligent robot equivalent.⁷⁵

The concept of the slow scan, connected to the idea of the space between, offers us a framework to tune into another species' dimension of space and time. How might latency factor into this interspecies slow scan? Latency means both revealing what is concealed and the time it takes for a data packet to travel from the sender to the receiver and back to the sender.^{76, 77} We are so often inclined to reduce latency with video streams, virtual gaming, and online meetings.⁷⁸ For the interspecies slow scan, we are *pursuing latency* than reducing it. Communicating with plants, with nature involves many uncertainties — we don't know what the other participant is going to say. Latency gives time and space for the message to transmit and assemble, and for humans to receive it.

When we let our minds wander, we start to notice things. Patterns emerge, line by line, and knit together to form a story. How we encode and read these stories matters — a quick scan reveals the familiar, while a slow scan might reveal something new.⁷⁹ This nuanced and interstitial data might lead to the formation of new possibilities, a novel idea, or direction. By constantly focusing on the immediate, we foreclose on these future possibilities and vice versa — focusing on the future, we miss immediate material needs.

Cooper's work embodied the simultaneous and layered data streams she sought to reconfigure on screen through an emerging digital language and interface design. Up until she died in 1994, Cooper's design for the human

(and posthuman) interface predicted and ushered in many of the processes and systems we use today, such as responsive interfaces and explicit feedback loops.⁸⁰ When describing long-range projects in "Computers and Design," Cooper said that "[t]he ultimate interface may well be a robot that can learn and think for itself."⁸¹

If we can imagine robots can think, can we not also see the same has been true for trees and plants and the fellow life on this planet? Cooper's approach to design and technology — one that embraced the messy ways in which things can interact, explored new configurations for existing systems, and prioritized response and feedback — provides a jumping-off point for my own design practice and investigation.



Image: Muriel Cooper and team, *Information Landscapes*, 1994 (video still)

⁷⁸ Goemans, Michel, and Jon Kleinberg. "An Improved Approximation Ratio for the Minimum Latency Problem." Department of Mathematics, MIT. MIT, June 18, 1995. Mokbel, Mohamed F., and Walid G. Aref. "Space-Filling Curves." Springer-Link. Springer US, January 1, 1970. https://link.springer.com/reference-workentry/10.1007/978-0-387-39940-9_349#citeas. <https://math.mit.edu/~goemans/PAPERS/latency.pdf>. The Minimum Latency Problem, also known as the delivery man problem, considers how to minimize the distance or time for the tour to pass through all the points on the route. This is interesting to consider in contrast to space-filling curves, a way of mapping multi-dimensional space that acts like a thread visiting every element exactly once. Tauba Auerbach works with space-filling curves known as Peano in their work.

⁷⁹ Chiang, Ted. "CHATGPT Is a Blurry JPEG of the Web." *The New Yorker*, February 9, 2023. <https://www.newyorker.com/tech/annals-of-technology/chatgpt-is-a-blurry-jpeg-of-the-web>. Another quality that slow scan and

SLOW SCAN

latency considers is compression. The self-similar process is lossy compression, in which we identify patterns and make inferences; the slow scan process operates losslessly, all data is kept for a rich understanding. These types of compression have taken center in the conversations about AI, neural networks and GPT3. I think we'll need both processes for AI and plants, just as we do with humans. We're experiencing parallels with OpenAI's GPT3. In a February 2023 New Yorker article, Ted Chiang described the language model as a blurry jpg, furthering this analogy with the idea of lossless and lossy. Chat GPT3 operates based on a neural network and a lossy algorithm that supposes the ability to understand material to save time and space (something humans do!). The idea is that rather than giving back direct quotes, the algorithm could paraphrase, or phrase originally. It works sometimes, but also breaks, erupting in "hallucinations" in which the text is fabricated instead of understood.

⁸⁰ "Looking Back on Muriel Cooper's Visions of the Future." *Eye on Design*. AIGA, December 5, 2019. <https://eyendesign.aiga.org/muriel-coopers-visions-of-a-future/>.

⁸¹ Cooper, Muriel, "Computers and Design," *Design Quarterly*, no. 142 (1989), 30, <https://doi.org/10.2307/4091189>.

Looking for Patterns & Finding Slippages

Self-Similar is a body of work that considers design for cross-species connection and communication. The title, borrowed from the mathematical description of fractals, is a quality that speaks to my process and methodology visually, conceptually, and structurally. How do things relate, arrange, and repeat? And what happens when there's a slip in the repetition — what new configurations, meanings, and novel connections unfold?

In search of an interface or series of connection points between humans and plants, I applied methodologies of juxtaposition, rhizomatic connecting, and pattern finding in my research, writing, and making, which came together through speculative design and a grounded theory approach. These methodologies were a search for resonance between the human and the vegetal worlds, a shared organizing or visual principle that imparts wonder at the strange but familiar.

Juxtaposition

My process begins in the everyday; the ongoing collection and documentation of life around me, primarily through photography and sound recording. I'm looking for patterns like the moss between the cracks, shadows on the sidewalk, the sound of the elements, or the remnants of wheat paste posters. These found and documented materials become part of an analytical process in which I juxtapose the organic with the inorganic, the human and nonhuman, and search for similarity in structure, color, visual, or function.

Rhizomatic Connecting

The methodology was inspired by my studies of moss, and is primarily about translation. The plant's growth is lateral, sprawling and multi-directional rather than neat linear progressions. In my work, scale-free arrangements emerge, resulting in nodes or concepts that are linked again and again.

This connection is about translation, but not in a one-to-one manner. It's more about recognizing a new configuration, a new dimension in which one or more concepts might intersect, spiral out, and relate. Referencing back to Minsky, this complexity and cross-connecting is "the nature of the mind: much of its power seems to stem from just the messy ways its agents cross-connect."⁸² Central to the process is that it's non-extractive and results in co-produced translations across media.

Pattern-Finding

Complementing analytic processing, juxtaposition, and connecting, is a semiotic approach looking for patterns that might constitute a recognizable sign or symbol and offer a meaningful connection.

Pattern-finding is about highlighting something that already exists or revealing a structure rather than inventing or generating something new. Part of this is also trying to embrace complex and entangled systems that generate in relation to one another and working with already present material. Haraway refers to this as *sympoiesis* — making with, thinking with, becoming with — a position that nothing is truly self-organizing or self-making.⁸³

⁸³ Haraway, 12.

This method of searching for a unique signature of a subject or material is something I developed specifically during my graduate study and development of this thesis. Prior, my visual language was based on simple geometric shapes. The methodology of pattern finding has yielded richer, more meaningful forms and complexity of configurations.

Encoded in the definition of the pattern is the concept of repetition or reproduction. What is the recursive function of the visual (or audio) motif/fragment? By repeating these patterns, reproducing them, and translating them into new forms, I hope for a slip-page or a glitch — that yields something entirely new or unexpected, like the fluidity and evolution of language over time.

⁸² Minsky, 17.



Capstone Project

My capstone, *Slow Scan Transmissions*, is a culminating expression of all these methodologies. *Slow Scan Transmissions* is a search for patterns in the space between the leaves of the trees. Juxtaposing these patterns with human written language, I generated a series of glyphs. The concept connects to artists' use of slow-scan tv. These non-extractive and co-produced translations are embedded in multi-year work of translations and interpretation with and alongside nature, across media and planes of existence and thought.

The process began through the arts of noticing — looking up at the trees and studying the space between their branches. Research was conducted across numerous locations in Manhattan's Lower East Side, Brooklyn, and upstate New York, and documented through photo, video, and audio. Collage occurred alongside these studies — working with physical prints of the photographs and cutting out the spaces between. Transplanted into a new context, these negative spaces became glyphs — visual signifiers and a record of the exchanges between the trees and me. An accompanying manifesto (p 59) provides a guide to using this process.

A video visualization features the tree crowns swaying (*their branches becoming rivers and arteries in the sky*) layered with a slow-scan reveal of the glyphs. Field recordings of biophonic conversation amongst trees, birds, and peat moss knit together in an audio soundtrack.

The capstone project was distributed as a mass-run broadsheet of 1000 copies that were circulated in botanical and community gardens, beloved and threatened parks, along with bookshops and community run spaces.⁸⁴ The broadsheet is a form for many-to-many communication, practiced by both people and the trees; the paper has an ease and ephemerality along with sensory qualities — texture, smell, ink transferal, and translucency. The blue ink is defamiliarizing, drawing the reader's eye to the space between the trees. The manifesto appears in small handwritten type around the border, bringing the reader closer. On the reverse, four glyphs are translated, presenting the possibilities of what might be found in the space between. A QR code connects the reader to the audio track and more information about the project.

⁸⁴ Helmore, Edward. "The Battle over a Vast New York Park: Is This Climate Resilience or Capitalism?" *The Guardian*, October 31, 2021. <https://www.theguardian.com/us-news/2021/oct/31/east-river-park-battle-adapt-climate-change-new-york-city>. East River Park is undergoing a massive and brutal transformation as part of the East Side Coastal Resiliency project. Protest of the plan has been widely documented as it illustrates overlapping crises, inequities, and priorities. More than 700 trees have been destroyed so far, and the remaining 500, existence is very much in jeopardy. See more at East River Park Action and 1000 People 1000 Trees.



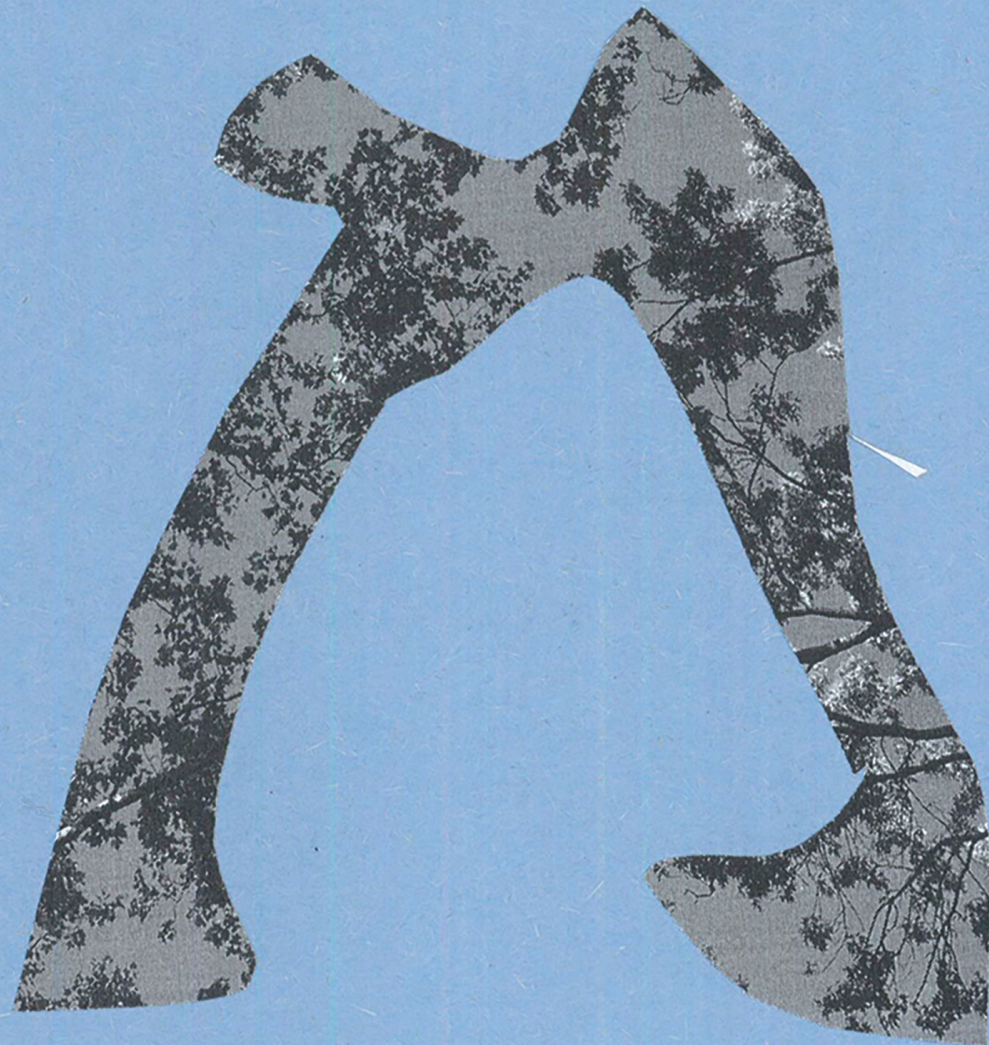
Images: *Slow Scan Transmissions* process, Fall 2022. (Top) field recording; (Middle) test prints with vellum. (Bottom) Distributing the paper in Alphabet City community gardens.

As I further my investigations and translations with trees and other vegetal beings, I'd like to continue exploring physical scale and how to make the print more interactive (e.g. *Muriel Cooper's rotation exercises*). I would also like to experiment with forms that are more dimensional, dynamic, and less certain. How might *Slow Scan Transmissions* take a new form as a weaving? Cast as an object? A syllabus? A projection? A room?



Image (right): *Slow Scan Transmissions*, Fall 2022.
Glyph from East River Park's pin oak trees.





The space between is conversation.
 A gap that makes legible an exchange.
 Visual resonance leaves room
 for breath and
 opportunity to meander.
 Slow scan transmissions.

Massive processes and intricate systems
 need space to attempt new configurations
 and generative possibilities.
 Branches built on a wave, connecting
 over, under, and out.
 Making room for tertiary readings and
 chance associations.
 A sinuous syntax,
 it curves and radiates.

Looking for spaces, we find patterns.
 Patterns allow for reproduction —
 code to build the self-similar
 Links piercing place and time.
 From which space blooms.

Image (left): *Slow Scan Transmissions*, Fall 2022.
 Glyph from East River Park's pin oak trees.
 (Previous spread, p 56-57): Plane trees on
 Pratt's campus.

A Move to Planet-Centered Ways of Being

My investigation of the self-similar mirrors my journey as a new mother, bringing with it a whole new way of relating. Time and space take on new meaning as I observe this tiny human's growth. Alongside and through my child, I experience the senses again — a witness to our ability to use touch, taste, and scent to navigate the world before we have words. And I (re-)experience a life in which

Image: (right) East River Park plane tree protected by 1000 People 1000 Trees. (Below) Various tree tops at Mountain Top Arboretum in the Catskills.



your caretakers are corporeal extensions of yourself. Even without words, we understand each other — through gestures, facial expressions, and shared context. Our patterns, routines, and rituals keep us connected and in conversation. How do we remember these early ways of sensing the world? The wonder and possibility? The attentiveness and care?

Human-centered systems that force legibility, shape, and boundaries onto plants, animals, and land are exhausting our planet. These short-sighted configurations and systems threaten our survival. Survival requires us to “stay with the trouble” and engage in “cross-species coordinations.”^{85, 86}

For Haraway, this translated to *sympoiesis* and making-with other species; for Tsing, it is finding value in the *assemblage*. For myself, it is the *self-similar*.

Self-Similar provides us with both a practical framework for what we can do with communication and a metaphorical one for how we can relate to fellow life on this planet. By considering that traits once considered exclusively human properties (*e.g., intelligence, world-making, and language*) can occur in plants, we can start to identify potential points of less-extractive/less-asymmetric exchange.

Research into Suzanne Simard’s wood wide web, Marvin Minsky’s artificial intelligence, cybernetic and biological computing, indigenous practices of energy exchange and plant matter vitality, fractal structures and the space between, Haraway’s sympoiesis, and Eduardo Kohn and Anna Tsing’s new anthropological paradigms, opens up space for new possibilities to de-center humans. Models for new forms of communication are found in Muriel Cooper’s interface design and Claude Shannon’s communication theory.

Fractal methods of organization and patterns give rise to new ways of connecting and communicating by holding open space and possibility. Relating and listening to plants matters because these actions can lead to relationships of care and the potential for new systems and structures in which we treat the planet as a living system rather than as an inert resource.

The goal of *Self-Similar* is not to restore nature to an imagined past but to imagine new possibilities for living on earth together. These new ways of seeing and being in the world are a gestalt shift — yielding perspectives that ultimately might help us leap from human to planet-centered paradigms. These

⁸⁵ Haraway, 58.

⁸⁶ Tsing, 22-23.

shifts are necessary if we want to maintain a habitable earth for all forms of life — including humans.

How do we decenter ourselves without eliding the responsibility we have to each other and the planet? How do we think beyond language? Or beyond our present conception of language? How do we switch from a mindset of scarcity to one of abundance? From paradigms of fear to joy — while still staying with the trouble? How do we design with plants and not for them? What new possibilities will we find in the space between?

Notes, Sources, Credits, & Extras

5

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A Playlist

Space 1.8, Nala Sinephro
Spiro World, Time Wharp
Cool It Down, Yeah Yeah Yeahs
Vol. 1: Femenine, Julius Eastman
Trans-Millenia Music, Pauline Anna Strom
Transmissions, Beverly Glenn-Copeland
Six Songs for Invisible Gardens, Green-House
Inner Song, Kelly Lee Owens
Green, Hiroshi Yoshimura
Urban Driftwood, Yasmin Williams
An Overview on Phenomenal Nature, Cassandra Jenkins
Crush, Floating Points
Furling, Meg Baird
Sun Piano, Laraaji
Parallelograms, Linda Perhacs
Journey Through The Secret Life of Plants, Stevie Wonder
The Expanding Universe, Laurie Spiegel

A Reading List

The Mushroom at End of the World, Anna Lowenhaupt Tsing
Braiding Sweetgrass, Robin Wall Kimmerer
Ducks, Newburyport, Lucy Ellmann
Staying with the Trouble, Donna J. Haraway
How to Blow Up a Pipeline, Andreas Malm
Milford Graves: A Mind-Body Deal, Inventory Press
Finding the Mother Tree, Suzanne Simard
The Overstory, Richard Powers
Nature: Collaborations in Design, Cooper Hewitt Design Triennial
Glitch Feminism, Legacy Russell
How Forests Think, Eduardo Kohn

Acknowledgments

So many thanks to my inimitable advisor Jean Brennan — what a joy it is to work and learn with you! Much gratitude to John Chaich and David Good for all your editing support. And forever grateful for my classmates whose brilliance is inspiring.

Thanks to Mast Books, Bluestockings Cooperative, and Printed Matter for displaying and sharing *Slow Scan Transmissions*.

And thanks to Willa for the abundance of joy, ease, and information you share. Talking through ideas with you makes them both possible and expansive.

Tree and Moss Credits

Trees from:
 East River Park
 Mountain Top Arboretum
 Pratt Institute
 Tompkins Square Park
 Brooklyn Botanic Garden
 Prospect Park
 McCarren Park
 Seward Park

Moss from:
 St Marks Place
 Alphabet City community gardens
 Ashokan Reservoir

Colophon

Design & Text: Janneane Blevins

Paper: Neenah Classic Crest® Solar White 110C FSC®; Mohawk Superfine Eggshell i-Tone®80T FSC®; and 100T dull coated FSC®.

Type: Fragment, Pangram Pangram; and Canela Text, Commercial Type.

Printing: SoHo Reprographics, New York

Binding: Hand-bound by designer

Edition: / 12

Self-Similar: Communication Between Species
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A gap that makes legible an exchange.
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A sinuous syntax,
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Looking for spaces, we find patterns.
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