Drawings done in collaboration with Sixuan Liu and Sarah Shi.

Lindsey Wikstrom

Futures

Halfway through quarantine, I visited the Magazzino Art Museum in Cold Spring, New York. I was interested in the building, as it was an adaptive reuse of an old dairy distribution center with a modest and minimal new addition by Miguel Quismondo. Although the architecture is beautiful, once inside, my attention was captured by a slim cedar tree—*Ripetere il bosco* [Repeating the forest], a work by Giuseppe Penone—in the corner of the private industrial gallery. Upon closer inspection, it was evident that Penone had meticulously excavated time itself, subtracting layers of fiber, delicately mining lignin from around each tiny branch and revealing a youthful body hovering between the rough ends of a thickly squared column. It was even more surprising that he started this exploration a lifetime ago, as the piece didn't look to have aged a day.[1]

The figure was simultaneously the fiber of a tree that grew for decades in the forest, the sectional memory of the tree as time passed, and a prized artwork representative of an artist's process, of an artist's thought. As the accumulation of many young, old, and dead trees, forests exist in a similarly layered fashion. Given their production of oxygen and thousands of years of providing fuel and building materials, forests are fundamental to life and civilization, which are synchronistically transformed and interpreted by human thought. The last 500 years of Eurocentric power produced imaginaries of nature, value, virtue, and therefore personhood, from *Dum diversas* (1452), a papal bull declaring moral authority to vanquish native flora, fauna, and persons "into perpetual servitude"; to the book *Sylva* (1664) that framed forests without Csartesian improvement as abandoned places; to the ongoing practice of imagining American forests as wilderness through the National Park Service (1916), as opposed to occupied and cultivated indigenous landscapes.[2] Since building materials come from colonized landscapes, the modern built environment is a derivative of cultural, spiritual, colonial interpretations of nature. The coproduction of societies and forests has been consciously understood and practiced by both colonizing and noncolonizing groups, each with an accompanying interpretation of nature's value as it relates to a specific definition of sustainability. To imagine equitable nonextractive living environments for humans and nonhumans, the supply chain for renewable building materials—its underlying protocols for cultivation, making, moving, using, and reusing—must be redesigned.

Witnessing *Ripetere il bosco* reminded me of "A Thing Is a Hole in a Thing It Is Not," a text by Robert Smithson that explores subtraction as a material in time. In the essay, Smithson evokes the remoteness of the Pine Barrens in New Jersey, an area I today frequent to look for mushrooms. He describes the chain of events that lead up to a construction project as "an array of art works that vanish as they develop."[3] In his own work, Smithson, thinking at the scale of architecture, turned his attention to the extraction, logistics, and labor that precede an object, rather than the object itself. He applied new aesthetic values to supportive infrastructural working landscapes, shifting the role of authorship toward a choreography of the ephemeral.

Forests and their counterpart landscapes exemplify the infrastructural choreography explored by Smithson. For some, forests were cultivated near mines, burned as fuel for the operations to enrich mineral-based cities, and located far from sites of habitation. For others, forests host complex heterogeneous social relationships among plants, animals, and humans, and clean the water and air. Is it possible to develop an in-between? Is it possible to respect forest relationships while also relying on them for building materials, namely mass timber? Are there enough trees to simultaneously absorb carbon and provide carbon-sequestering building materials?

The United Nations predicts that over the next forty years, 2.4 trillion square feet of space will be added to the planet.[4] If all new buildings were constructed using mass timber, they would require, depending on the species cultivated, either 1 billion acres of monocultural forest or 2 billion acres of mixed species forest. This estimate assumes that one harvested acre can provide the volume of wood needed to build between 2,500 to 800 gross square feet, roughly storing 25 tons of carbon and avoiding 9.2 tons of carbon emissions.[5] With 9.8 billion acres of forest on the planet and 30 percent already managed for production, meeting the predicted demand is well within our planet's capacity. In this simplified estimate, only 10 percent of all managed forests would support a completely plant-based urban environment.

If all new buildings were mass timber buildings, they could store around 25.8 billion tons of carbon and avoid around 10 billion tons of carbon emissions.

When the timber market is strong, deforestation is less of a concern. What is of concern is biodiversity. Forests are susceptible to deforestation when land is transformed into agriculture or urban occupation, which is a direct consequence of the economy. In Brazil, the Amazon is more profitable for beef production than carbon sequestration, indigenous residence, and a medicinal incubator combined.[6] Therefore, increasing the value of trees on the market would in turn protect them. This might mean paying forest owners for carbon offsets during cultivation and increasing the demand for timber to incentivize more planting. If forests are the primary source for building materials, the market requires replanting to ensure supply. In other words, under the right conditions, timber construction has the potential to protect forests. However, the type of trees that are replanted remains concerning.

Climax community forests—forests that have grown for many hundreds of years—are made of many different species. Unfortunately, mass timber utilizes only a few: spruce, pine, and fir (the most common species used for mass timber fabrication) and larch, oak, and beech (less common). Products that incorporate few species will eventually incentivize monocultural cultivation. What about maple, birch, sycamore, and hemlock, among others? Incentivizing the replanting of biodiverse forests would require a parallel expansion of mass timber products to reflect a wider range of tree species. One example of species-driven laminate timber is the invention of oriented strand board (OSB). Before OSB, aspen trees were interpreted as having little value and were constantly cleared like weeds.[7] After the invention of OSB, aspen grew into one of the most cultivated trees on the planet. Similarly, researchers at the University of Massachusetts Amherst are studying eastern hemlock's unique shear properties when arranged as rotated plys within cross-laminated timber (CLT).[8] And at the House of Natural Resources at ETH Zürich, researchers have been monitoring a post-tensioned hardwood hollow-core biaxial beech-based floor system.[9]

One of the reasons species-driven mass timber is difficult relates to Smithson's focus on the design of supportive landscapes. Not only would mass timber products need to evolve and become diversified, but the entire "array of art works" would require rethinking. Harvesting roads, saw blades, kilns, graders, certifications, assembly details, and expert skill sets would need updating, too.

Beyond fiber variation, trees have other unpredictable habits. They're not static creatures. They tend to grow and migrate in mixed-species congregations, responding to temperature, rainfall, erosion, and resources. Warmer temperatures, longer growing seasons, and elevated carbon concentration in the atmosphere due to climate change are making trees act more sporadically than ever. Growing regions for beech, alder, pine, fir, and maple are moving quickly poleward at a clip of more than 300 feet per year, while oak, birch, hickory migrate slowly, at around thirty feet per year, risking collapse.[10] This dynamism is challenging foresters to start offering "assisted range expansion" packages to their tree constituents rather than geostatic conservation plans.[11]

It's been shown that what forest ecologist Suzanne Simard calls "mother trees" store and distribute valuable information and nutrients to younger trees to help them resist droughts and pests. The quality of the information is dependent on the diversity of forest relationships and on the protection of older trees as libraries. It is unknown whether their knowledge storage will also accelerate. It can be expected that slow-moving tree species will be lost due to

climate change. Even so, global forest productivity, cover, and biomass are still projected to increase in the next forty years because of increased interest in carbon concentration. This change will increase carbon sequestration while decreasing the price of wood globally.[12] Determining a proportional relationship between timber markets and regional but migrating biodiversity for plant-based cities is highly complex. Perhaps artificial intelligence might help us design a more equitable supply chain.

In October 2020, ForesTrust, LLC, launched its blockchain technology to provide a secure conduit for transparency and traceability across complex value chains and when navigating cross-border certification requirements.[13] This collaboration between the US Endowment for Forestry and Communities, IBM, and key stakeholders is designed to provide a cost-effective network to track wood and wood fiber accurately and efficiently from the forest to the consumer. Today, wood is the only building material with third-party certification programs in place to verify origin from a responsibly managed resource. This makes perfect sense because how would a fundamentally extractive mine be certifiably sustainable? It would be impossible to certify the ethical sourcing of iron ore, the workings of a clinker kiln, or the distillation of coke from coal. Forests can be managed as generative, renewable, and healthy. Forests can also be Is It Relevant in Our World Today involve modern-day slavery, extract without replanting, and destroy ecosystems. The fact that wood *can* be certified proclaims its centrality to a future low-carbon civilization. But, as wood crosses borders and oceans, much like it has for 500 years, certifications can easily be biased, misused, and falsified. Tracking material to the source would improve confidence that wood wasn't illegally logged, in turn helping to avoid networks of forced labor and deforestation. Blockchain protection and tracking has the potential to grow into a more distributed, anticolonial operation that protects local human rights while also connecting economies, as opposed to optimizing material flows through another world-standardizing system.

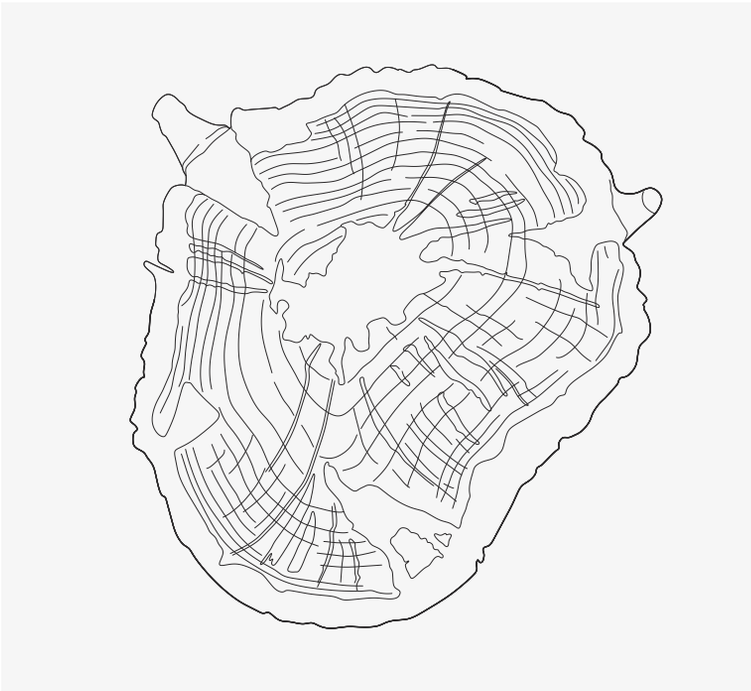
There is an opportunity to imagine blockchain systems applied at smaller scales, too. If everyone who owned trees was connected to sawmills, affordable housing projects, deconstruction companies, and composting groups, material might flow more freely. This continuous tracking of material would help stakeholders resist global flows and more easily predict local inputs and outputs. If every tree is logged and tracked as a form of citizen science—similar to the way NASA relies on amateur astronomers, perhaps—a cooperative network has the potential to function as a catalyst for urban-adjacent forests as the primary zone for growing new construction materials.[14]

The first patent for CLT was filed in Tacoma, Washington, in 1923. The document outlined the concept for gluing small pieces of softwood together "to produce a new article of manufacture suitable for many commercial purposes in which the original wood could not be used, and in which its properties render it superior to other existing substances."[15] The original goal for plant-based composites still hasn't been realized at the scale envisioned in this 100-year-old document, whose speculation is even more urgent today given that most cities are made of mineral-based materials with high embodied energy. Designing the built environment to operate in synchrony with a dynamic, biodiverse forest represents a chance to coproduce nature and society in ways that have never been done before.

An architect's job is to negotiate between human needs and those of the earth itself, between humanity's present and future, between local and nonlocal scales and sites. Material specification, something all architects do, is the moment that either existing or new

supply chains are either affirmed or denied. A material specification is a vote for the factories, the working conditions, the trade agreements, the mining protocols, and the fuel utilized. Decisions at this scale profoundly impact the long-term health of people, both locally and globally. In these moments, architects become carbon brokers, with a responsibility to understand the local and global effects of these choices on the project at hand and visualize trade-offs. Not surprisingly, from this professional vantage point, beauty and narrative emerge as immensely important, as both are highly personal. The scientific documentation of "mother trees" blended indigenous knowledge into a modern interpretation of the forest, transforming the way forestry conservation is now being rethought today. Similarly, species-diverse mass timber cities would require "an array of art works" involving all kinds of people from forest to factory to construction and deconstruction, each capable of contributing their own interpretation of wood, drawing from Indigenous and diasporic, ancient, and futuristic views to craft an anticolonial, pluralistic supply chain.

Crafting a new relationship between society and nature requires storytelling and persuasion. As such, the vehicles of stories, beauty, and spirituality are the contracts through which carbon is given value. It isn't inevitable that the worst effects of global warming will be avoided; similarly, plant-based cities aren't inevitable. Instead, if they are to exist in the future, today they require an array of advocates, choreographers, and interpreters of the forest.



Notes

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