MASS Haptic

CHRISTOPHER MEYER
University of Miami

Keywords: Forest, Carbon, Environment, Mass-Timber, Wood-Architecture.

ABSTRACT

The forested lands in the southeastern United States account for approximately 40% of the nation's 521 million acres of timberland, which translates to about 208.4 million acres in U.S. forestry region eight[1]. These timber stands primarily consist of softwoods, with various uses in wood markets including wood pellets, pulp, chip-in-saw products, and sawtimber. Long-term timber management strategies prioritizing low-grade fiber products may hinder the forest's capacity to satisfy the lumber demands of construction markets, especially with the rise of mass timber and other solid wood product markets.

Demonstration projects have long been employed to showcase new processes, innovative materials, and creative ideas addressing contemporary issues. The MASS Haptic pavilion is a call to action for Florida and the greater Southeastern region to utilize local timber resources and manufacturing capabilities to build sustainable structures from renewable materials. This initiative responds to concerns about climate change, energy consumption, carbon emissions, resource management, and environmental degradation. Specifically, the pavilion explores the potential of using small-diameter timber, or deformed timber and timber stands affected by disease, as structural elements in buildings. It focuses on processes involved in utilizing low-grade timber—material that is unsuitable for the production of standard commercial lumber—as the primary structural component in its roundwood form.

The work of MASS Haptic is set against the backdrop of the Southern Yellow Pine (SYP) forest, which covers over 60 million acres in the Southeastern region of the United States, according to reports from the USDA U.S. Forestry Service. This forest consists of rapidly growing tree species, capable of producing straight timber suitable for dimensional lumber in approximately 15 to 25 years. Additionally, SYP forests also produce small-diameter trees that are often bent, twisted, or crooked, making them suitable primarily for the production of pulp, paper, cardboard, or fuel. The design and construction of the MASS Haptic pavilion aims to utilize timber identified as unsuitable for producing solid lumber or engineered structural products.

The goal of connecting locally sourced materials through forest processes is to educate students, faculty, and the greater Gainesville, Florida community about the forest's potential. Repurposing low-grade timber offers economic, environmental, and energy benefits while rethinking possibilities for long-term carbon storage. MASS Haptic explores the structural contributions of trees, focusing on the innovative repurposing of low-grade materials into high-grade products.

THE FOREST

Forests are essential to modern society, providing raw materials for various products and processes that people rely on, including paper, cardboard, wood fiber plastics, fuel, and construction materials. Forests are intricate living systems that engage in a continuous exchange of oxygen and carbon with our atmosphere. During this process, approximately 50% of the dry mass of wood consists of stored carbon in wood fibers. The pervasiveness of wood fiber in a wide range of products has made the health, productivity, and long-term viability of forests critical to the wood demands for domestic and global markets. The southeastern forests- for this paper is defined as timber stands composed of Southern Yellow Pine [SYP] *[long leaf or pinus palustris, short leaf or pinus echinata, loblolly or pinus taeda, and slash pinus elliottii]* species and principally stretching from Northern Florida through Georgia, Alabama, Mississippi, Arkansas, Louisiana, the Carolinas and into Texas - contribute 58% of the domestic wood fiber volume to industrial wood products and 18% of the global outputs.[2] Misconceptions about the potential of forests have unintentionally fostered a disconnect between wood as a product and wood as a material resource. The key distinction is that wood fiber is an output of the forest, while wood products are outcomes of human-centric interests and markets. There is a significant risk in decoupling the forest from the act of building and the creation of buildings; historically, the forest was the original building material depot, an idea

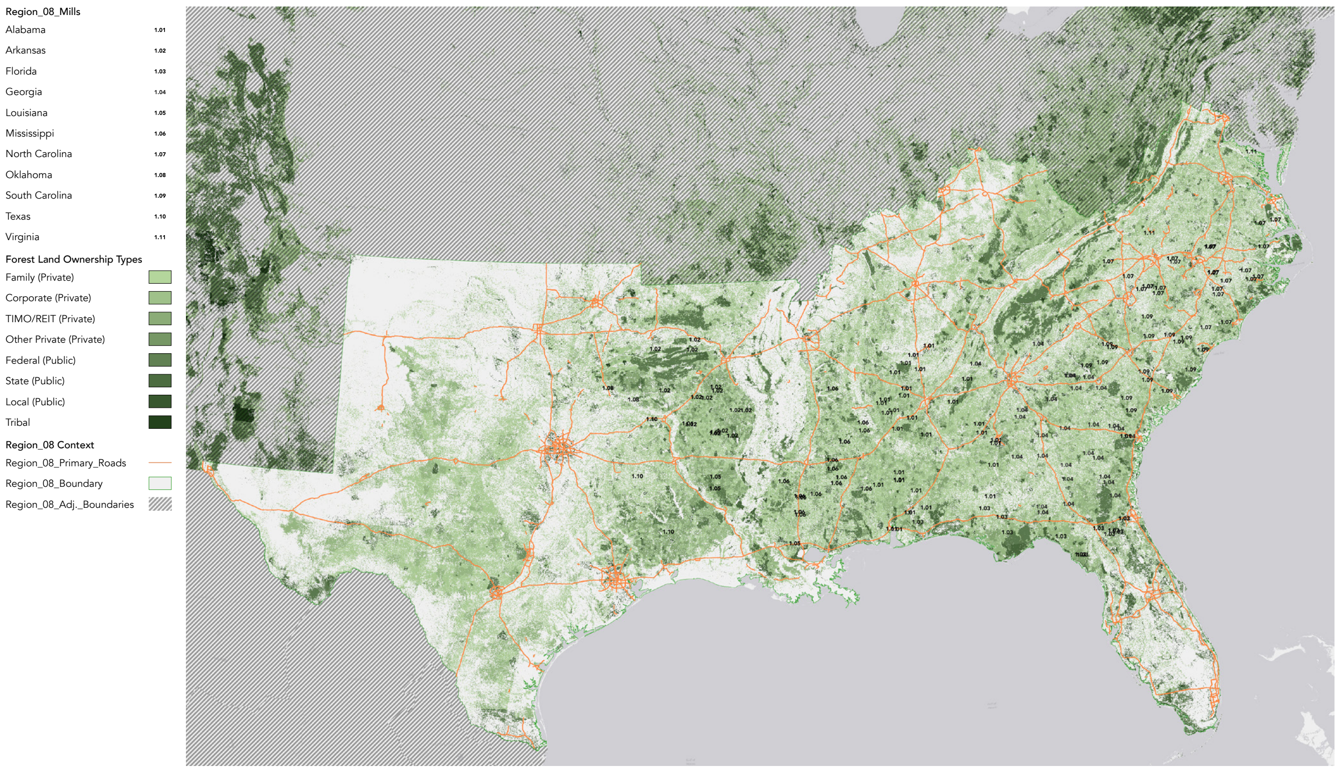

Figure 1. The over 200 million acres of SYP forested lands and the network of miles stretching across the southeastern U.S. in forestry region eight contribute almost 60% of the domestic industrial wood fiber. Image Credit: Littoral Urbanism Lab

grossly overlooked today. Forests are resilient in their ability to metabolize the pressures from disease, insects, droughts, and a range of natural disasters including fires, flooding, and winds from tornados and hurricanes—yet, forests remain vulnerable to anthropocentric interests. Narrow perspectives on the potential of forests limit architecture's ability to address contemporary energy and carbon-related environmental challenges, ultimately squandering time-sensitive opportunities. Investigating new methods and techniques that extend beyond traditional wood products is essential for clarifying the energy, carbon, and material complexities inherent in natural forest cycles. This exploration will help reaffirm wood as a material with unique properties and characteristics.

Reiterating the forest as the original building supply depot encourages an interrogation of scale and capacity when considering the development of a carbon and energetic agenda for architecture and the environment; is there enough of the correct timber available to support wood building needs? The forested lands in the southeastern United States account for about 40% of the nation's 521 million acres of timberlands (208.4 million acres in U.S. forestry region eight[3]). (fig. 01) These timber stands are primarily used for softwoods and are typically categorized for wood pellets, pulp, chip-n-saw, and sawtimber. The U.S. leads the production of industrial roundwood for pellet, pulp, and paper products, while also being the largest consumer of roundwood for pulp and paper production.[4] Despite leading in both the production and consumption of industrial roundwood, the current analysis indicates that the U.S. forests are growing more fiber than is being harvested, which means that the growth of timberlands has surpassed the demand for wood fiber products.[5]

FOREST AND PRODUCTS

Current forest management strategies that guide the development of Southern Yellow Pine forests in the southeastern United States operate under a clear mission; to grow trees for industrial wood production serving the paper, pulp, pellet, 2x4, and 2x6 dimensional lumber markets. These SYP product-based strategies broadly focus on cultivating small-diameter trees between five to nineteen-inch diameter at breast height [DBH][6] and approximately fifteen to twenty-five years old. It is important to note that the age of SYP timber stands is not the sole determining factor in deciding whether to harvest. The long-term effects of timber management strategies prioritizing low-grade and low-quality fiber products could hinder the forest's ability to satisfy the demand for high-grade dimensional lumber and structural products in the construction market.[7] Increased pressure on material streams from timber stands is also associated with smaller-diameter timber and timber affected by pine needle rust, fusiform rust, crooked growth, and structural deformations. Compromised trees are usually designated for lower-grade products, including the pellet, pulp, mulch, and fuel markets. Revising traditional timber harvesting guidelines could enable the assessment of timber stands for nonconforming trees that do not meet structural grading certifications. The goal is to extract underutilized timber for upcycling, removing them from the pellet, pulp, mulch, and fuel markets and repurposing them for structural uses, all while adhering to broader land and forest management strategies.

The paper, MASS Haptic, makes a case for small-diameter, low-grade timber, defined as less than eight inches DBH, to be assessed and graded for structural capacity when left in round-wood form. It is critical to note that the impacts on industrial timber productivity related to product outputs are a result of several factors: sawmill demand, wood reserves, weather patterns, environmental conditions, and workforce availability. These factors are fluid and can change daily; consequently, it is challenging to predict the forces behind the supply of SYP logs from the forest and the demand for logs from sawmills. Irregularities in supply and demand factors for local mills and manufacturing plants can result in high-grade logs suitable for chip-n-saw processes being diverted to pulp and paper mills that most often source low-grade logs. This glitch in the system stems from economic factors that ultimately undermine the precise sorting of wood as a healthy and sustainable option focused on addressing energy and carbon matters related to efforts combating climate change. Regardless of the grade of the timber and material streams, there is a clear connection in the forest's contribution to the balance of carbon pools[8], energy flows, and environmental health. The forest remains one of the most productive naturally occurring machines capable of large-scale carbon sequestration and storage on the planet, holding great potential in addressing the imminent challenges of climate change humans are facing. The IPCC defines a carbon pool as a reservoir or system that has the capacity to accumulate or release carbon[9]; a general description of the forest cycle.

CARBON AND PRODUCTS

Carbon is stored in trees and the forest at large for varied lengths of time. Leaves and needles store carbon for relatively short-term cycles as they grow, are shed, and fall to the forest floor where they decompose and release the stored carbon back into the atmosphere. The limbs of trees and root systems store carbon for a relatively longer duration as they grow, break off, or are left behind by logging crews to decompose on or in the forest floor, over time releasing the carbon into the atmosphere. Most importantly, the trunks of trees can be a relatively long-term storage mechanism as they are valued for use in 'wood products' in the form of furniture, flooring, finishes, sheet goods, framing, and structural members for example. When timber is harvested for various wood-based products, the duration of carbon storage across time follows a similar pattern to that of the forest. For example, paper and cardboard generally represent short-term carbon storage. In contrast, structural components in buildings, such as dimensional lumber, beams, columns, and mass timber elements, represent mechanisms capable of longer-term carbon storage.

With the growing acceptance of mass timber construction techniques in the United States, it is feasible to envision solid wood architectures as long-term carbon banking, applicable to small and large-scale buildings. A commitment to architecture as a potential bank for the long-term storage of carbon requires the design of buildings to adhere to three critical elements: 1. The architecture or wood components must remain intact for the carbon to remain banked. 2. Using mass-based, solid wood approaches for carbon banking is most effective when the wood fiber is used abundantly. 3. The carbon released in the processes associated with material extraction, processing, manufacturing, transportation, and erection of timber, wood products, and wood buildings must not exceed the carbon stored in the wood fiber being allocated as a 'carbon bank'.

To free the forest from abstract and human-centered demands, we need to assess the real, tangible value of pursuing material efficiencies, material economies, political interests, and the strong commitments that serve the idea of wood as a 'product' over wood as a material. By restructuring our understanding of wood as a raw material, the discipline of architecture provides space for expanding the agency of wood. An architectural agenda acknowledging materiality through its physical properties and not as a product is by no account a new idea. In 1987, Gilles Deleuze and Félix Guattari's, *A Thousand Plateaus*, reminded architects of the peril in the act of isolation, be it in material, tools, techniques, or processes; *'Even technology makes the mistake of considering tools in isolation: tools exist only in relation to the interminglings they make possible or that make them possible. Tools are inseparable from symbioses or amalgamations defining a Nature-Society machinic assemblage. … They presuppose a social machine that selects them and takes them into its "phylum": a society is defined by its amalgamations, not by its tools. … An assemblage has neither base nor superstructure, neither deep structure nor superficial structure; it flattens all of its dimensions onto a single plane of consistency upon which reciprocal presuppositions and mutual insertions play themselves out'.*[10] Reconnecting the forest to architecture is an attempt at dissolving the boundaries drawn to claim the disciplinary authority to energize the 'interminglings' of building and material. A summation of a relationship between making and material is described in the publication *Advancing Wood Architecture, A Computational Approach*, *'It is a question of surrender to the wood, then following where it leads connecting operations to materiality, instead of imposing a form upon matter…'.*[11] As a design and making exercise, MASS Haptic acknowledges the importance of materiality by surrendering the imposition of design will to the SYP forest, following where the small diameter, quick growing, and generally low-grade timber forest might lead.

MASS HAPTIC

Demonstration projects have long been used to showcase the potential of new techniques, innovation, or creative ideas aimed at addressing contemporary disciplinary challenges. The design of MASS Haptic[12] focused on utilizing low-grade or low-quality timber as the primary structural system. The use of low-grade timber serves two purposes: 1. transferring wood fiber from short-term to long-term carbon storage pools and 2. expanding the utility of raw wood resource (timber) pool to support the timber demands for manufacturing structural construction materials. The MASS Haptic as a demonstration project posits the question: Can low-grade timber (non-structurally graded) be upcycled for use as primary structural components in buildings? If so, what are the limiting factors?

The design of MASS Haptic was not about creating a new structure, but rather about using architecture as a vehicle revealing outcomes and the challenges posed by building policies, processes, and common practices. The structure is an amalgamation of various influences, starting with forestry and extending to the accepted building regulations, along with the Health, Safety, and Welfare standards required for permitted structures.

The project involved collaborations between the architectural firm Atelier Mey and the University of Florida's School of Forestry, Fisheries, and Geomatic Sciences to explore the potential of working forests at the Austin Cary Forest (ACF) Learning Center. The working forest used as the material depot for MASS Haptic was situated thirteen miles northeast of the project site in Gainesville, Florida. The proximity between the forest and the project site helped to minimize the energy associated with transportation and logistics while highlighting the environmental importance of sourcing materials locally.

The design process had an unexpected starting point, focusing on the available material resources before a design idea was

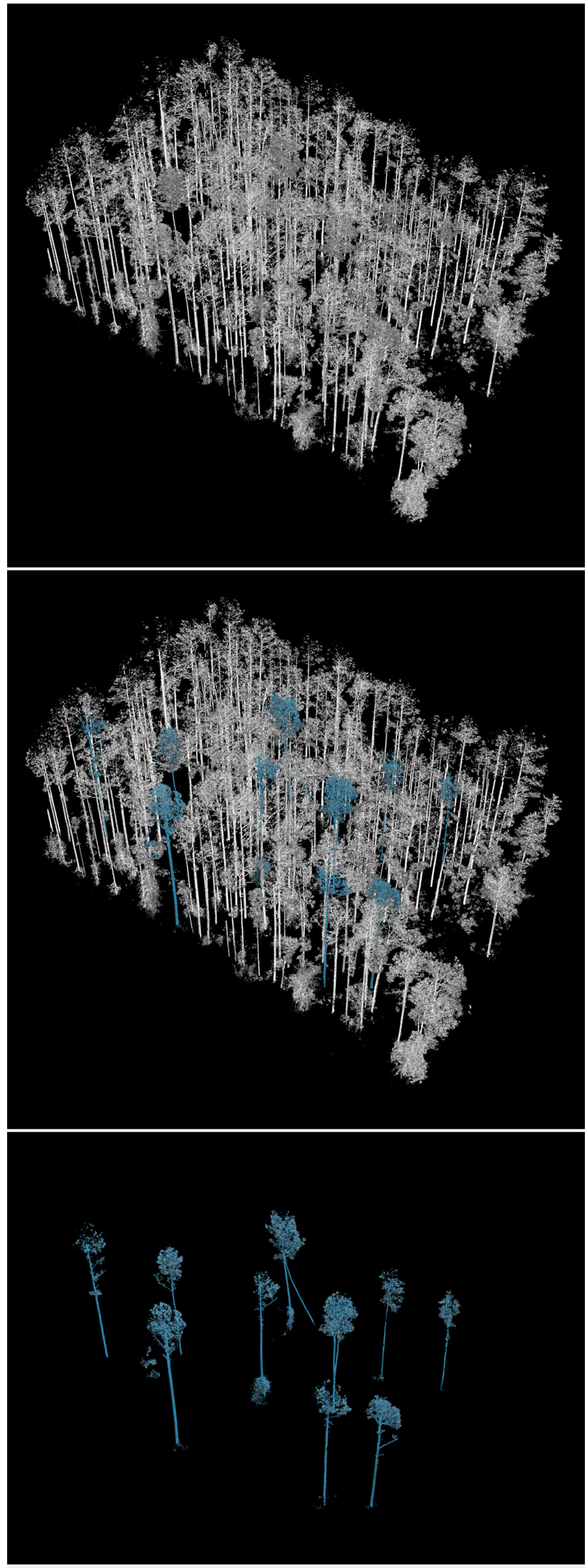

Figure 2.

TOP: The Austin Cay Learning Center hosts an active 2,500-acre Southern Yellow Pine working and learning forest, a forest MASS Haptic utilized as a 'material products catalog. A three-dimensional scan of a 100' by 200° section stood as a 'Material Depot', in which the design team and forestry groups identified trees not suitable for traditional milling or processing of dimensional lumber. The lesser-grade trees are kept whole and used in their log forms as structural members. Considering the potential of hyper-local, low-grade trees to be used as structural members, addresses critical issues of climate change and environmental degradation: the amount of embodied energy in the harvesting, processing, and transportation is limited due to the proximity of the forest to the building site, and the carbon sequestered in their fibrous mass as a structural member in opposition to paper or chips is a long-term storage condition. Image Credit: Atelier Mey

MIDDLE: The trees highlighted in Blue were identified to be harvested, and filtered for their size, shape, disfigurement, twists, bends, or irregularities. Image Credit: Atelier Mey

BOTTOM: These trees have irregular shapes and abnormalities, making them unsuitable for high-quality timber. They are intended for use in pulp, pellet, and chip markets. The project's goal is to redirect these trees from being ground into pulp for low-grade structural material, and instead utilize them for other purposes. Image Credit: Atelier Mey formulated. The project team began by visiting a one-hundred-and-fifty-foot by one-hundred-and-fifty-foot section of the ACF forest which was subsequently three-dimensionally scanned and converted into a point cloud to be analyzed and cataloged. Using the point cloud, the timber stand was initially filtered by DBH, selecting trees ranging from four to nine inches in diameter. (fig. 02) The selected trees were further examined to identify character defects including fusiform rust, twists, exaggerated tappers, bends, crooks, sweep, and general formal distortions that would result in a designation of lower-quality logs. With the diameters and defects cataloged, the timber was digitally dissected into thirteen-foot lengths and organized based on character flaws (fig. 03). A list of the selected trees for harvest was delivered to the UF Forestry partners where the logging team located the selected trees within the ACF staff to be felled. The harvested timber was rough cut into thirteen-foot lengths, debarked using draw knives, and left to dry under cover in the open air for two months, where the logs awaited review by a third-party log grader.

MASS Haptic was constructed on the University of Florida's main campus, located in Gainesville, Florida, where all buildings require a permit for construction based on university standards. The permitting process mandates that structural materials used in the project be graded and certified for structural integrity. The timber harvested from the ACF required a third-party log grader to evaluate and certify all logs designated for use as structural components in the project were verified as structural sound and following grading standards. (fig. 04) The third-party log grader evaluated twenty-nine SYP logs in total, of which twenty logs met the minimum structural standard. The twenty passing logs were certified and stamped as debarked, green NO.2 material.

Using small-diameter trees as structural components presents significant challenges because there are currently no grading or certification standards for logs measuring less than five inches in diameter, even if they demonstrate perfect grain characteristics and display no visible deformations. The smallest log approved by the grader for structural use measured six inches in diameter

Figure 3. The selected trees have irregular shapes and abnormalities, making them unsuitable for high-quality timber. They are intended for use in pulp, pellet, and chip markets. The project's goal is to redirect these trees from being ground into pulp for low-grade structural material, and instead utilize them for other purposes. Image Credit: Atelier Mey

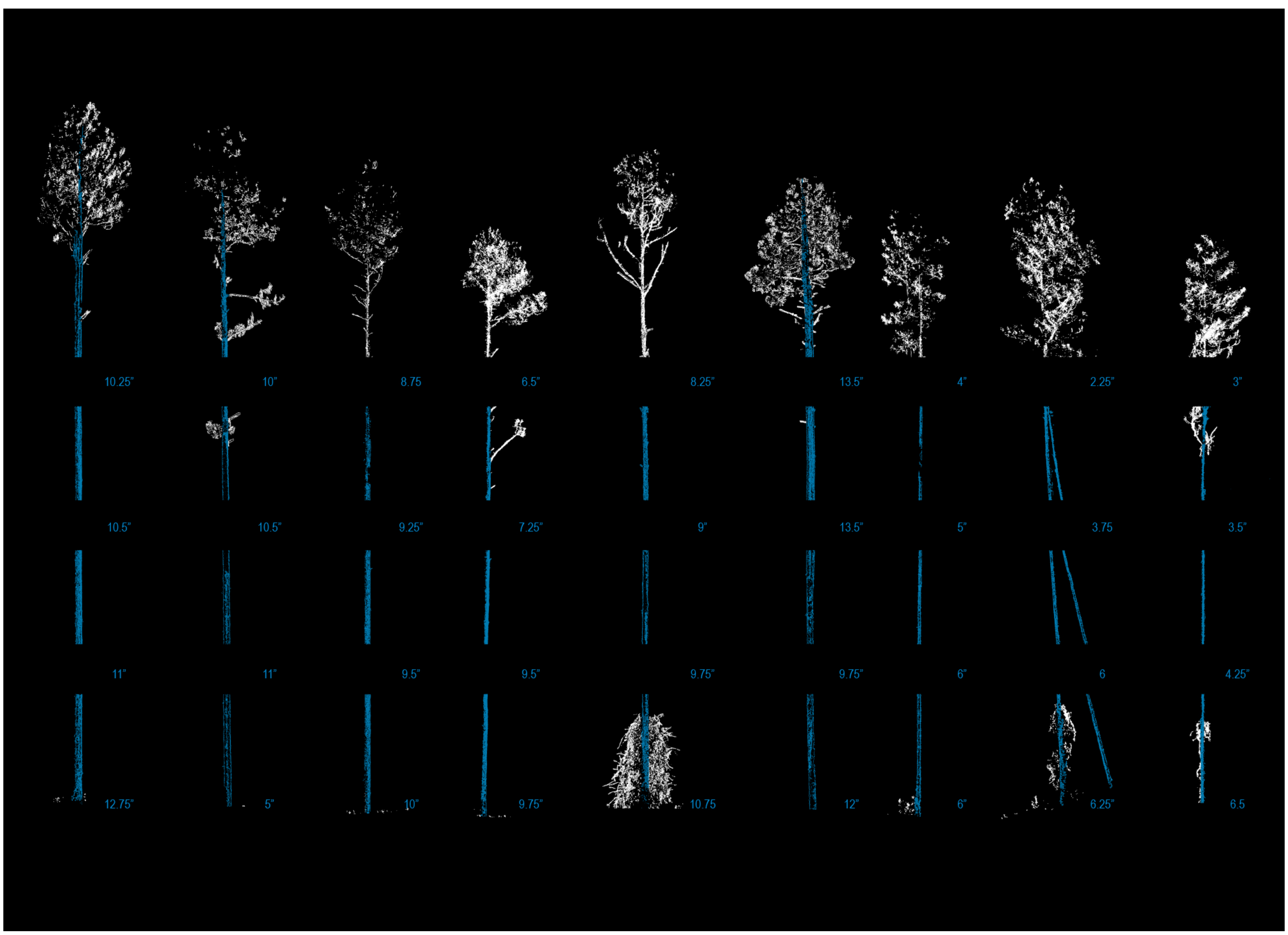

Figure 4. An example SYP log after review and certification by a third-party log grader. For the MASS Haptic pavilion, the TP 55 stamp remained visible on all logs through the final installation of the structure. Image Credit: Atelier Mey

at mid-span on rough-cut, thirteen-foot logs. Several logs did not pass inspection solely due to insufficient diameters.

The log grading process identified a critical issue with using undersized or irregular timber as structurally graded and certified material. Traditional log grading establishes minimum diameter requirements, a minimum number of growth rings, and specific slope criteria, effectively excluding small-diameter timber measuring approximately five inches or less from certification. Developing specific grading criteria for small-diameter timber intended to remain in roundwood form could help address the underutilization of wood markets for structural materials.

MASS Haptic serves as an educational pavilion featuring twenty-eight columns, reflecting the planting densities of the common SYP working forest, which range from five hundred to six hundred and fifty trees per acre. Out of the twenty-eight columns, only thirteen were determined by the structural engineer to be necessary for supporting structural loads. The structurally contributing columns are mixed in with the non-structural columns and left anonymous. Four of these thirteen columns are designed to support gravity loads, while the other nine columns are responsible for transferring lateral loads from the roof to the foundation system. The variety in log size, bends, twists, deformations, and orientation of the columns poses a challenge for visitors to understand the structural logic and discern which column performs which function.

The columns are anchored to the ground using a network of helical ground screws, able to be retracted at the end of the pavilion's life, leaving the site relatively undisturbed. The roof, made of 5-ply SYP-Cross Laminated Timber [CLT] and consisting of two panels joined by a half-lap joint, each approximately twenty-by-ten feet, is supported by a network of twenty-eight roundwood columns. The SYP-CLT panels were manufactured in Dothan, Alabama, located 250 miles northwest of the project site, using traditional mass timber manufacturing and digital fabrication CNC processes. The SYP material used to create the CLT panels was sourced from Florida forests and processed at Rex Lumber, a mill based in Graceville, Florida, aligning with the design agenda of sourcing materials hyper-locally or regionally. The structure hosts an outdoor learning lab, a respite from the Florida sun and rain, and a gathering place for faculty and students moving through the campus. A thick mat of long-leaf pine needles, a byproduct of the SYP working forest covers the ground under the pavilion's roof. (fig. 05) MASS Haptic invites students and visitors to exist amongst the roundwood columns, the logs are characters in the space engaging in the learning lab discussions.

LEARNING FROM THE FOREST

The theoretical approach of using low-grade, high-carbon materials for durable building components is easier to grasp than its practical application. MASS Haptic tested the idea of using undersized, character-deficient trees as structural columns, revealing the challenges of implementing such innovative ideas within existing policies and regulatory processes. While MASS Haptic succeeded in its construction, it highlighted the difficulty of introducing new processes and techniques into building codes. The pavilion demonstrates the potential for change by showcasing the feasibility of using low-grade materials, but it also underscores the need to address and revise existing policies.

In October of 1943, through a speech, Sir Winston Churchill offered a call to action following the war's end in the early stages of a post-war reconstruction visioning of the House of Commons, *'We shape our buildings, and afterward, our buildings shape us.'*[13] Cleverly implied in Churchill's words, delivered with the backdrop of World War II, is a request to see our actions as having much grander implications of which we will not escape the repercussions. Churchill's aphorism is as important as it is anthropocentric, an unintentional overlooking of the implication our buildings levy on the environment from which they are extracted. The paper asks the reader to substitute an ecocentric *'We'* for Churchill's anthropocentric *'We'*, a call to action that now highlights the seriousness of an architectural agenda conscious of energy, carbon, and the environment.

The extraction and harvesting of materials required for construction can and often do carry significant environmental implications. An architecture of humility recognizes the importance of prioritizing material properties and characteristics, aligning design choices with a broader energy and environmental

Figure 5. Twenty-eight SYP columns extracted and processed 13 miles from the project site, support a 5-ply SYP-CLT roof of MASS Haptic, a site adjacent to the North Lawn on the main campus at the University of Florida. The pavilion plays host as an outdoor classroom and gathering spot for students and faculty to escape the relentless Florida Sun. Image Credit: Atelier Mey .

agenda. Gregory Bateson clarified the significance of the environment in the *Steps to an Ecology of Mind, 'If the creature destroys its environment, it destroys itself'.*[14] MASS Haptic is grounded in the potential of the over 200 million acre forest stretching across the southeastern U.S., abound with low-grade, small-diameter trees. The pavilion is an acknowledgment of the form of the forest as an architectural agenda hiding in plain sight.

ENDNOTES

1. Oswalt, S. N., & Smith, W. B. (2014). U.S. forest resource facts and historical trends. Washington, D.C., D.C.: U.S. Dept. of Agriculture, Forest Service.
2. The Southern Timber market to 2040. (2002, October). Journal of Forestry. Retrieved October 11, 2024, from https://academic.oup.com/jof/article/100/7/16/461301 Prestemon, P, Jeffrey & Abt, C, Robert pages, 16–22.
3. U.S. forest Resource facts and historical trends. (2014, August). USDA U.S. Forest Service. Retrieved February 1, 2024, from https://www.fs.usda.gov/sites/default/files/legacy_files/media/types/publication/field_pdf/forestfacts-2014aug-fs1035-508complete.pdf
4. Alderman, D., Brandeis, C., Forest Products Laboratory, & Southern Research Station. (2023). United States Forest Products Annual Market Review and Prospects: Country Market Report, 2021-2025 [Report]. https://unece.org/sites/default/files/2023-11/US_FPMAR_2023-2024_Nov3.pdf
5. Southern Forest Research Assessment Consortium, State of the Forest Resources in the U.S. South, 2019, Rajan Parajuli, Ph.D.
6. FOR357/FR426: Timber Inventory: A primer for landowners. (n.d.). Ask IFAS - Powered by EDIS. https://edis.ifas.ufl.edu/publication/FR426
7. Horx-Strathern, O., Varga, C., Guntschnig, G., & Zukunftsinstitut Österreich GmbH. (2017). The future of Timber Construction: CLT – Cross Laminated Timber: A study about changes, trends and technologies of tomorrow. In Zukunftsinstitut Österreich GmbH. https://www.storaenso.com/-/media/documents/download-center/documents/product-specifications/wood-products/clt-technical/stora-enso-the-future-of-timber-construction-en.pdf
8. Bracho, R., Martin, T. A., Vogel, J. G., Cropper, W. P., Jr, Celis, G., et al. (2023b). Two decades of carbon dynamics in an actively-managed, naturally-regenerated longleaf/slash pine forest. Forest Ecology and Management, 548, 121408. https://doi.org/10.1016/j.foreco.2023.121408
9. Land Use, Land-Use Change and Forestry. (n.d.). https://archive.ipcc.ch/ipccreports/sres/land_use/index.php?idp=13. 5.4.1.1. Identification of Carbon Pools & Appendix III. Glossary
10. Deleuze, G., & Guattari, F. (1987b). A thousand plateaus: Capitalism and Schizophrenia. page 90
11. Menges, A., Schwinn, T., & Krieg, O. D. (2016a). Advancing wood architecture. In Routledge eBooks. https://doi.org/10.4324/9781315678825
12. page 1 (in reference to Deleuze & Guattari, A Thousand Plateaus)
13. Churchill, Winston, "House of Commons Rebuilding", HC Deb, 28, Oct.1943, c403, House of Lords. https://api.parliament.uk/historic-hansard/commons/1943/oct/28/house-of-commons-rebuilding
14. Bateson, G. (1972b). Steps to an ecology of mind: Collected Essays in Anthropology, Psychiatry, Evolution, and Epistemology. Jason Aronson. https://ejcj.orfaleacenter.ucsb.edu/wp-content/uploads/2017/06/1972.-Gregory-Bateson-Steps-to-an-Ecology-of-Mind.pdf, page 339 (item 4)