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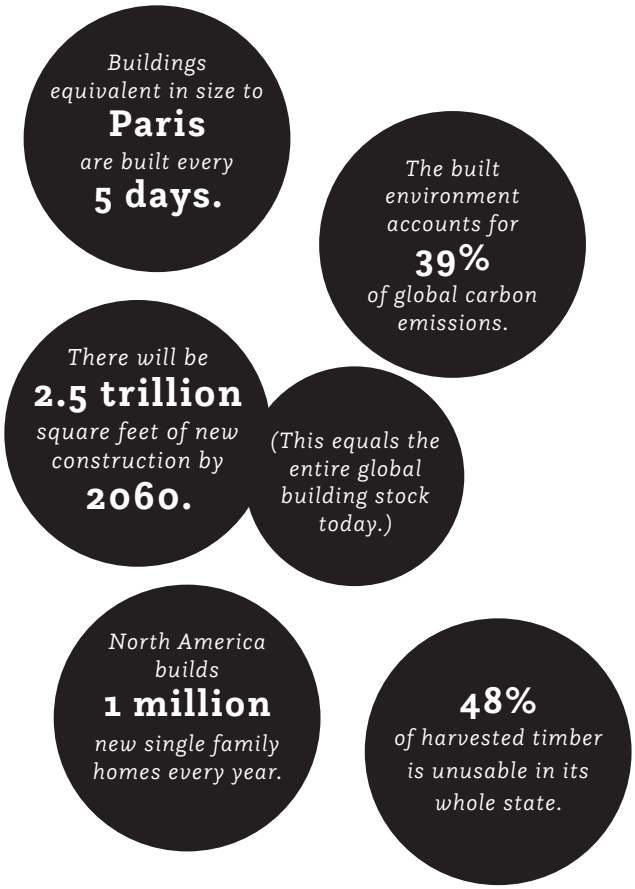
Title

"Design from Tree to Timber: Building Non-Planar Futures"

Course Description

Overview

Wood construction constitutes over 90% of new homes in the United States, and construction and building operations account for 39% of global CO_2 emissions. Meanwhile, 48% of harvested timber is unusable in construction in its whole state due to irregularities, instead being broken down for use as fuel (releasing captured carbon into the atmosphere) or in engineered wood products such as OSB or MDF (which introduce formaldehyde adhesives and limit the ability to compost upon decommissioning).



This advanced research studio will address these questions early in the building pipeline by interrogating the production of timber buildings beginning with the milling of logs into lumber. The course asks:

- How might the irregularities present in trees be strategically incorporated into construction and design processes?
- How can novel fabrication technologies facilitate the understanding, evaluation, and use of this material?
- What radically different futures for timber architecture are possible if construction is not limited to planar boards, straight columns and beams, and flat sheets?

The studio will examine and reimagine material and technological processes inherent to wood construction beginning with forestry practices. Students will make use of an entirely new timber construction technology – a robotic sawmill invented by an interdisciplinary team led by the instructor at the University of Virginia. The course will be structured around a series of physical fabrication exercises in which elements and assemblies are built, tested, and evaluated with both quantifiable performance metrics and a narrative around the social and cultural reception of the developed material systems. The course will culminate in the realization of full-scale prototypes that prove out developed material systems and present their architectural potentials.

Research Merit

Non-planar timber presents opportunities to expand the use of carbon-sequestering materials in construction, building on the recent success of mass timber systems including Cross-Laminated Timber (CLT) and Mass Plywood Panels (MPP). The UVA robotic sawmill technology enables the use of wood that is too irregular for conventional milling processes, creating opportunities to increase material utilization rates and efficiencies, as well as the ability to incorporate natural material geometries into the construction of building components. Additionally, the technology proposes additional value-added manufacturing, through the use of wall or floor geometry to improve performance characteristics (for example, using wall geometry to produce lateral stiffness) and enable new formal and spatial opportunities in buildings.

According to a 2022 study by the UVA Weldon Cooper Center for Public Service ("The Economic Impact of the Agriculture and Forest Industries in Virginia," T.J. Rephann), forest products and industries account for $23.6 billion annually and support over 108,000 jobs in the Commonwealth. Forestry and forest products represent the third-largest private industry in Virginia. This course will empower students to engage with and innovate within this economically and environmentally critical industry.

Pedagogy

The course is planned as a six credit advanced research and design studio. It is interdisciplinary and vertically

integrated, available to B.S.Arch., M.Arch., and MLA students who are admitted through a lottery process. Students will learn to evaluate irregular timber materials through 3D scanning and custom machine visioning techniques, design strategies for novel non-standard timber assemblies, and physically fabricate 1:1 material prototypes. Students will define the metrics and criteria for evaluating their material systems, develop speculative designs suggesting radical architectural futures, and document and present their work through a popular press release and academic research paper, to disseminate the work beyond the University and bring it to a public audience.

Work Plan for Course Development and Implementation

The instructor is currently scheduled to begin teaching an advanced research studio at the University of Virginia School of Architecture beginning in spring 2025. The School recently began assigning these studios to faculty for periods of three years, with the intent that the course be developed and refined across several iterations.

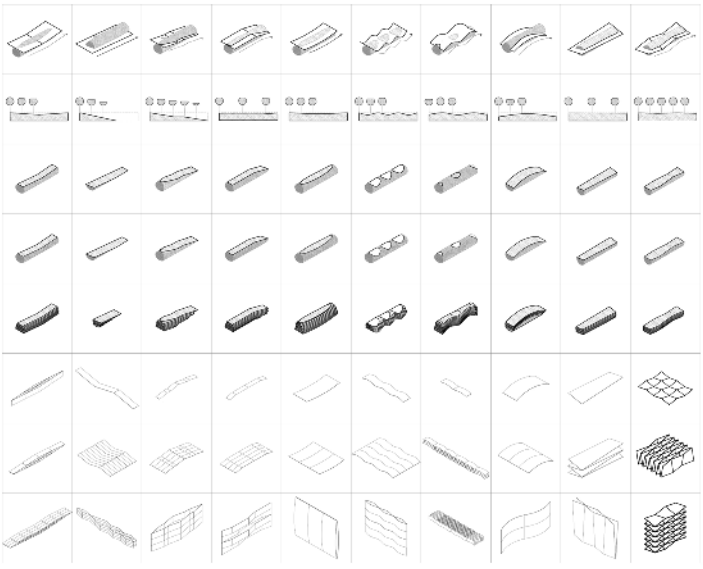
The SLB | ACSA 2024 Timber Education Prize will allow students to develop novel research aimed at leveraging the natural irregularities in logs, and develop future-oriented engineered wood products that expand upon existing mass timber products, allowing for new material and structural efficiencies and new possibilities for architectural space. Students will address technical questions of fabrication, construction, and material performance in addition to considering the social and cultural dimensions of the developed material systems. Running the course for several concurrent years will allow the testing of pedagogy through various scales of production and methods for introducing course concepts to students. Most importantly, it will provide time to show progress and pursue sustained funding sources and industry partnerships.

Working toward the first implementation of the course in spring 2025, relationships will be built to secure opportunities for material acquisition, industry partnerships, and additional funding. Local partners will be contacted for possible site visits, including local sawmills and a wood truss assembly plant. The instructor will continue collaborating with UVA Sawmilling, a university group that saves campus waste logs from the chipper and makes them available for student projects and faculty research. Through building the course, opportunities to bring research into the world will be pursued through external funding sources, including from NSF, USFS, and USDA, as well as other forestry and wood construction organizations and commercial wood industry partners.

Lessons learned in the 2023 Mass Timber Design Build Faculty Workshop at the Tallwood Design Institute will be incorporated into the course.

Robotic sawmill developed by a team led by Schumann at UVA. This technology is fully operational as of summer 2023. Students will be introduced to, trained on, and have access to the technology for fabricating material prototypes in studio.

Detail of timber elements milled with the robotic sawmill technology and deployed in "Crinkle Cuts," a pavilion constructed by a workshop at NJIT.



Initial studies into non-planar wood assemblies.

List of Selected Readings or Other Sources

On Materials

Manuel DeLanda, "The New Materiality," *Architectural Design* 85(5), 2015.

R. Bruce Hoadley, *Understanding Wood: A Craftsman's Guide to Wood Technology* (Newtown: The Taunton Press, 2000).

Dirk Hebel and Felix Heisel, *Cultivated Building Materials:Industrialized Natural Resources for Architecture and Construction* (Basel: Birkhäuser, 2017).

Daniel Ibañez, Jane Hutton and Kiel Moe, *Wood Urbanism: From the Molecular to the Territorial* (New York: Actar, 2020).

Seetal Solanki, *Why Materials Matter: Responsible Design for a Better World* (Munich: Prestel, 2018).

Andy Goldsworthy, *Andy Goldsworthy: A Collaboration with Nature* (Harry N. Abrams, 1990).

Lindsey Wikstrom, *Designing the Forest and other Mass Timber Futures* (Oxfordshire: Routledge, 2023).

Jeana Ripple, *The Type V City: Codifying Material Inequity in Urban America* (Austin: UT Austin Press, Forthcoming).

Ursula von Rydingsvard, *Ursula von Rydingsvard: The Contour of Feeling* (Philadelphia: The Fabric Workshop and Museum, 2018).

Giuseppe Penone, *Giuseppe Penone: The Inner Life of Forms* (New York: Gagosian, 2018).

On Technologies

Mario Carpo, *The Alphabet and the Algorithm* (Cambridge: MIT Press, 2011).

Mario Carpo, *The Second Digital Turn: Design Beyond Intelligence* (Cambridge: The MIT Press, 2017).

Nicholas Negroponte, *Being Digital* (New York: Knopf, 1995).

Neri Oxman, "Age of Entanglement," in *Journal of Design and Science*, MIT Press, 2016.

Gordon Pask, "The Architectural Relevance of Cybernetics," in *Architectural Design* 7/6, John Wiley & Sons Ltd, 1969.

Bernard Rudofsky, *Architecture Without Architects* (New York: Doubleday, 1964).

Julia Watson, *Lo—TEK. Design by Radical Indigenism* (Cologne: Taschen, 2020).

Alexander Langlands, *Cræft: An Inquiry Into the Origins and True Meaning of Traditional Crafts* (New York: W. W. Norton & Company, 2017).

On Ecologies & Cultures

Daniel Barber, "After Comfort," *Log* 47, 2019.

Robin Wall Kimmerer, *Braiding Sweetgrass: Indigenous Wisdom, Scientific Knowledge and the Teachings of Plants* (Minneapolis: Milkweed Editions, 2015).

Neil MacGregor, *A History of the World in 100 Objects* (London: Penguin Books, 2012).

Reinhold Martin, Jacob R. Moore, and Jordan Steingard, *Green Reconstruction: A Curricular Toolkit for the Built Environment* (New York: Columbia University, 2021).

Don Norman, *The Design of Everyday Things* (New York: Basic Books, 2013).

David Wallace-Wells, *The Uninhabitable Earth: Life After Warming* (New York: Tim Duggan Books, 2019).

*Initial list subject to change through course development.

"Sylvan Scrapple" is a temporary installation built by a team of paid student researchers and displayed at Exhibit Columbus in fall 2023. It is the first work fabricated using the new robotic sawmill and represents one of the simplest possible applications of the sawmill technology.

Past materials & fabrication teaching: Circular Chromatics, reciepient of the 2023 ACSA Design Build Award, in which students deployed three biomaterial systems they developed. Published in Schumann, Kyle. "Research-Build: Biomaterial Invention through Design Studio Pedagogy." ACSA 2023. St. Louis, MO: 2023. 293-302.

Past teaching: Introductory assignment to build skills in analog and digital modeling and fabrication processes. Published in Schumann, Kyle. "Learning from Logs: Introductory Analog and Digital Pedagogy Addressing Material Irregularity." CAADRIA 2022: Post-Carbon. Sydney, Australia (virtual): 2022. 355-364.