

The 100-Mile Building: Bioregional, Biogenic Architecture

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Abstract

IN THE URGENT DRIVE TOWARDS DECARBONIZATION OF THE BUILDING INDUSTRY, ARCHITECTURE AND ENGINEERING PRACTICES MUST ADDRESS BOTH OPERATIONAL AND EMBODIED CARBON. YET ALTHOUGH OPERATIONAL ENERGY CONSUMPTION HAS LONG BEEN A CONCERN FOR ARCHITECTS IN THE US, EMBODIED CARBON HAS ONLY RECENTLY BECOME A FOCUS OF BUILDING CODES AND REGULATIONS. TO RESPOND TO THESE MORAL AND LEGAL OBLIGATIONS, INCREASINGLY MORE TOOLS ARE AVAILABLE TO ASSESS EMBODIED CARBON, BUT ASPECTS OF MATERIAL SELECTION AND SPECIFICATION REMAIN OPAQUE INCLUDING THE COMPLEX FACTORS OF ENVIRONMENTAL AND SOCIAL HARM RESULTING FROM EXTRACTION, PRODUCTION, AND TRANSPORT OF BUILDING MATERIALS. AIMING TO OVERCOME THESE CHALLENGES, THE AUTHORS POSIT THAT ARCHITECTS SHOULD MAXIMIZE THE USE OF BIOREGIONAL, BIOBASED BUILDING MATERIALS. TO EXPLORE THIS IDEA WITH STUDENTS, THE AUTHORS CO- TAUGHT AN ELECTIVE COURSE FOCUSED ON THE IMPLICATIONS OF MATERIAL SELECTION WITH THE GOAL OF EMPOWERING SOON-TO-BE GRADUATES WITH THE KNOW HOW AND AMBITION TO TRACE MATERIAL HISTORIES AND DESIGN WITH LOCAL, NATURAL BUILDING MATERIALS, A PROJECT WE TERMED, *THE 100-MILE BUILDING*. THIS PAPER DISCUSSES THE PEDAGOGICAL METHODS AND OUTCOMES OF TWO ITERATIONS OF THE COURSE, CONCLUDING WITH A DISCUSSION ABOUT AN EXPANDED RESEARCH AGENDA ON THE APPLICATION OF THE 100-MILE BUILDING STRATEGY.

Introduction

A recent United Nations Environment Programme report affirmed that “building materials are set to dominate climate change.”¹ In the urgent drive towards decarbonization of the building industry, architecture and

engineering practices must address both operational and embodied carbon. Yet although operational energy consumption has long been a concern for architects in the US, embodied carbon has only recently become a focus of building codes and regulations. For example, effective July 1, 2024, the California Green Building Standards Code (CALGreen) requires 45% building reuse, a 10% reduction in embodied carbon shown through whole building life cycle assessment, and documentation about the global warming impact of materials.² To respond to these moral and legal obligations, increasingly more tools are available to assess embodied carbon including a host of product rating systems and life cycle assessment software. However, aspects of material selection and specification remain opaque, including the complex factors of environmental and social harm resulting from extraction, production, and transport of building materials. Recognizing these challenges, the authors posit that architects should, whenever possible, maximize the use of local, natural, renewable building materials.³ Using local materials reduces transportation emissions, and plant-based materials draw down carbon from the atmosphere, which can be stored when used in buildings. As Martha Lewis, Senior Architect at Henning Larsen Architects, exclaimed, “Materials appear to be at the crux of multiple dilemmas, which for the optimist could also make them the key to new solutions.”⁴ To explore material solutions, the authors co-taught an elective seminar for upper-level students focused on the implications of material selection with respect to sites of extraction and manufacturing, human labor and exploitation, and the climate crisis. The goal is to empower soon-to-be graduates with the know-how and

ambition to trace and specify local, natural materials through a project we termed, *The 100-Mile Building*.

Education is vital to fully comprehend and reconcile with the built environment's contributions to climate change. Because of industrialization, capitalism, and globalization, building materials are extracted, manufactured, and transported around the world and specifying or purchasing a material from the opposite side of the planet is normal practice. Charlotte Malterre-Barthes berates the industry for claiming neutrality about its debt to the natural world and calls for "politicizing details and components in order to connect them to contemporary forms of resource extraction and appropriation, as well as, ultimately, to rethink the production of our infrastructure, our cities, our homes, and our lives."⁵ Similarly, Dipesh Chakrabarty recognizes, "The more we acknowledge our emerging planetary agency, the clearer it is that we now have to think about aspects of the planet that humans normally just take for granted as they go about the business of their everyday lives."⁶ Instead of taking materials for granted, architects, engineers, and construction managers must learn (in school and in practice) about material sourcing, production, and transport and their impacts on people and the planet.

Although a material may serve positive aesthetic or performative purposes in a building, its pre-construction history may have caused negative human or environmental impacts. These "externalities" caused by materials as they are moved from one site to another is discussed in *Reciprocal Landscapes* by landscape architect Jane Hutton. She advocates for thinking about materials not as commodities, but continuous from the land from which they came, recognizing that, "the anthropogenic ecological crises that we witness today are not the system malfunctioning; they reflect instead the logical outcomes of capital accumulation based on using things up as if there were no limits or costs."⁷ These entrenched systems may seem insurmountable to

restructure, even as architects recognize the need to reform material cultures of the building industry, but these are design problems.

One way to take stock of material origins is to work with local supply chains where the health and impacts of materials can be more easily assessed and monitored. Building with local, natural materials is both an ancient idea and one that is seeing resurgence. Use of these materials in buildings has a much longer history than the globalized supply chains that dominate today. Returning to indigenous or vernacular ideas about building with local, natural materials has the potential to inform reductions to the carbon footprint or increase carbon storage in buildings.⁸ When possible, keeping transactions local enables designers and specifiers to be more connected to and knowledgeable about material sources and their impacts on the environment, laborers, and community.

Working with local, natural materials evokes the concept of bioregionalism, where humans nurture the natural environment and where nature is "valued on its own terms" rather than a resource to be exploited.⁹ The bioregional movement has a long history and there are many definitions; one well-known conceptualization of bioregionalism emerged during the back-to-the-land movement in California in the 1970s. In "Reinhabiting California," Peter Berg and Raymond Dasmann define bioregionalism as both "geographical terrain and a terrain of consciousness—to a place and the ideas that have developed about how to live in that place."¹⁰ Similarly, ecofeminist Judith Plant advocated for bioregionalism, stating, "Bioregionalism means learning to become native to place, fitting ourselves to a particular place, not fitting a place to our pre-determined tastes. It is living within the limits and the gifts provided by a place, creating a way of life that can be passed on to future generations"¹¹ Critics, dismissed bioregionalism as utopian and out of reach in the globalized capitalist economy,¹² and the bioregionalism movement in the 1970s and 1980s did not

gain mainstream support. However, the concept is reemerging as advocates see the potential in bioregionalism to promote the environmental and human benefits of self-sufficiency, cooperation, locality, and conservation. To counter the human drive towards technology and progress in what Maria Puig de la Bellacasa calls “technoscientific futurity”, she advocates for slowing down and paying attention to the health of natural environments in order to repair the harms caused by exploitation of the land resulting from industrialized capitalist systems.¹³ Likewise, a bioregional approach involves learning from vernacular practices, indigenous traditional ecological wisdom¹⁴, regenerative agriculture, and local craftspeople to expand knowledge about how to care for nearby natural and human communities.

This kind of local care for the land and its inhabitants is seen in the work of a growing number of architectural practices. Firms dedicated to a bioregional approach to design include, for example, Atelier Luma in France, Material Cultures based in the UK, and Earthscape Studio in India. These practices demonstrate the viability of working with local biogenic materials to focus on healthy environments, support local economies, limit transportation emissions, and spark material innovation. Atelier Luma sources local agricultural byproducts and creates new materials through lab-based design, development, and testing. Their book, *Bioregional Design Practices — Pratiques de design bioregional*, showcases their material experiments and applications.¹⁵ Similarly, Material Cultures is a well-known advocate for a bioregional approach. Their ongoing project, Growing Place, for example, harnesses timber, clay, straw, and reed through regenerative and community-based practices for the slow development of infrastructure to support the land and the local community. They advocate for these ideas in their manifesto, *Material Reform*.¹⁶ This ethic is shared by Earthscape Studio’s Eternal Experience Pavilion in Peermade, Kerala, India. They worked with local farm laborers to construct a vaulted structure made from three layers of thin bricks sourced

within 40 kilometers. They aim to work with organic materials to connect humans and nature through architecture.¹⁷

Bioregional Buildings: Teaching Methods and Outcomes

Learning from these and other examples, the authors set out to educate architecture students about the positive and negative implications of material selection. Through two iterations of an upper-level elective seminar, the faculty created presentations, workshop demonstrations, and assignments to decipher the problems of commonly specified materials such as rigid foam insulation and cement board. The students then explored opportunities for design and healthy environments when specifying biogenic and biobased materials. The 10-person enrollment (both years) enabled a studio-type environment where faculty could support each student in their learning. The course’s learning objectives involved investigating and sharing knowledge about biobased material sourcing, designing and constructing building assemblies from biogenic materials, and discussing strategies to advocate for changes in material specification practices.

Faculty presentations covered topics including introductions to material health, building codes and regulations in support of biobased building, labor ethics, composting, bioregionalism, and contemporary biogenic practices. The faculty-led material workshops focused on woodcraft, algae-based bioplastics, hemp insulation, and earthen plasters. These activities developed students’ knowledge and techniques in working with natural materials, aiming to help students build confidence in designing with the materials in their future practices. Additionally, the making activities throughout the course provided varied ways to engage different types of learners and to create hands-on, learn by doing experiences.

Investigative Reporting: Tracing Materials

To build foundational knowledge about conventional versus biobased building materials, in the first assignment titled, *Investigative Reporting*, students teamed to trace and compare the extraction, production, and labor practices of common off-the-shelf building materials juxtaposed to a biobased alternative. For example, one team delved into insulation where one person investigated rigid foam while their teammate uncovered the process of making denim insulation. The project brief posed the following questions to prompt the investigations:

- + *What is the material's history? How has extraction and/or production impacted the culture of the place and the local environment?*
- + *Where are the sites of extraction? How might production impact nearby neighborhoods?*
- + *Where are the sites of production? How might production impact nearby neighborhoods?*
- + *How is the raw material processed and what are the byproducts of that process? [percent of "other" materials, waste, carbon]*
- + *What is the distance of transport between extraction and production? [miles between these]*
- + *What type of human labor is involved in extraction and production? [human hours, OSHA category of risk, justice concerns]*
- + *Are the laborers unionized?*
- + *What other information can you uncover about the extraction or production of the material?*

The faculty acknowledged that certain questions, especially pertaining to labor, would be unanswerable within the four-week assignment period. Students were encouraged to explore Parson's Healthy Materials Lab resources and search for a range of sources for information including the material manufacturer's

websites, Environmental Product Declarations (EPD), Safety Data Sheets (SDS), and third-party assessments such as Declare. Students were also asked to attempt at least one phone interview with a manufacturer's representative. Faculty coached the students about qualitative interviewing methods following authors Rubin and Rubin, including how to set the tone of the conversations and ask open-ended questions. Students were advised to start with a prepared list of questions, but to allow the interview to be conversational.¹⁸ Over the course of the assignment, faculty met with the student teams three times to discuss their findings and provide guidance on how to fill gaps in their investigations.

Outcomes of Investigative Reporting

Although not all students were able to connect with a person over the phone, some received email responses. Perhaps not surprisingly, the biobased manufacturers were generally more willing to have a conversation. One fruitful interview occurred with Travis Joslyn, founder of Herron Paint, a small linseed oil paint manufacturer in Healdsburg, California. He generously talked for an hour about harvesting flax, linseed oil production, manufacturing the paint, and the environmental harms resulting from industrial pigment sourcing including deforestation, erosion, and water pollution.¹⁹ (Fig. 1) Another student talked with a representative from Carnegie Fabrics, a PVC-free company, who makes the wall covering, Biobased Xorel. They explained that 60-85% of the Cradle-to-Cradle-certified material is biobased and a large percentage of that content is derived from sugarcane waste, harvested in Brazil, whereas the fabric is manufactured in Belgium.²⁰

The culminating task for the *Investigative Reporting* assignment involved verbal presentations accompanied by slides formatted using a faculty-created template.

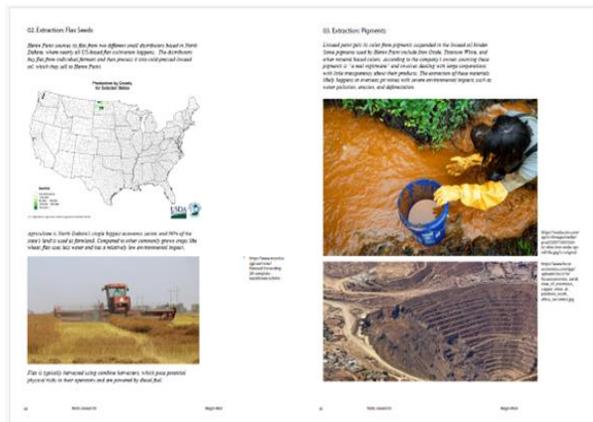


Fig. 1. Pages from the “Cover the Earth” presentation on paint by Megan West and Julia Clough.



Fig. 2. Pages from the “Unraveling Textiles” presentation by Rachel Leong and Sarah Wise.

The student presentations informed classmates and faculty about the history, extraction, manufacturing, and transportation involved in producing a range of materials. (Fig. 2) In the two iterations of the course, presentations focused on different manufacturers of paint, wallboard, insulation, roofing, stucco, plaster, and cement-board cladding. Students were surprised to learn that some of the most seemingly unhealthy materials, such as Owens Corning’s Foamular XPS rigid foam insulation, were GREENGAURD Certified, which caused students to be skeptical about ratings systems. Learning about the harms of fossil-fuel and chemical-based products versus their healthier alternatives springboarded the next assignment.

The 100-Mile Building: Theory and Application

Building from the knowledge gained through the presentations on biobased materials by faculty and students, the next five-week assignment, titled *The 100-Mile Building*, asked new student pairs to select a city on the western seaboard to explore biobased building assemblies that would be possible within a 100-mile radius. Some students chose cities close to home or related to their thesis projects. Cities investigated include Seattle, Portland, San Francisco, San Luis Obispo, Los Angeles, San Diego, and Albuquerque. Students searched for materials in the categories of structure, insulation, interior and exterior finishes. Like *Investigative Reporting*, the *100-Mile Building* assignment asked students to gather information including thorough material descriptions, finding the sources of extraction or harvesting, deciphering the production process including use of fossil fuels or carbon inputs, and linking relevant data sheets. Although some biogenic materials like straw can be transported from farm to building site, students examined a range of biobased materials, many of which require some sort of processing involving energy and labor.

Getting oriented to a region involved first looking at indigenous and local vernacular building materials for clues about bioregional availability and appropriateness. They then searched for regional producers of natural building materials including straw, hemp, clay, and wood products. Additionally, the US Department of Agriculture’s “BioPreferred Program Companies” website provides a searchable database of biobased materials through a map where one can enter a mileage radius, although most products are not building related.²¹ As students discovered biobased materials within their chosen region, some conducted interviews when it was possible to connect with a producer.

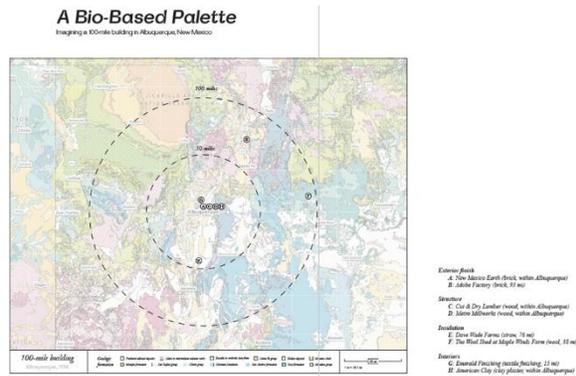


Fig. 3. Biobased material sourcing within 100 miles of Albuquerque, NM. Image source: Katherine Neuner and Rachel Leong.

Outcomes of the 100-Mile Building Investigations

Through internet searching, phone interviews, and mapping exercises, students realized the difficulties of sourcing biobased materials within a particular geographic region. The process proved challenging because many databases of biobased materials do not

have searchable fields focused on geographic location. Many students resorted to using Google Maps to search key terms like “hemp” and “straw”. In the end, all teams discovered two materials for each category of structure, insulation, interior and exterior finishes, but it was surprising to learn the struggles in sourcing those, even for cities that have the benefit of both manufacturing and agriculture within 100 miles.

To translate information to graphic representation, students created diagrams depicting the sites of extraction or harvesting, and sites of manufacturing. (Fig.3) This visualization proved helpful in understanding the biobased material resources available within the 100-mile limit. In some instances, to find components for each category of building material, students needed to extend the radius to 200 miles. (Fig. 4) This is still a hopeful prospect given the current reality of the construction industry.

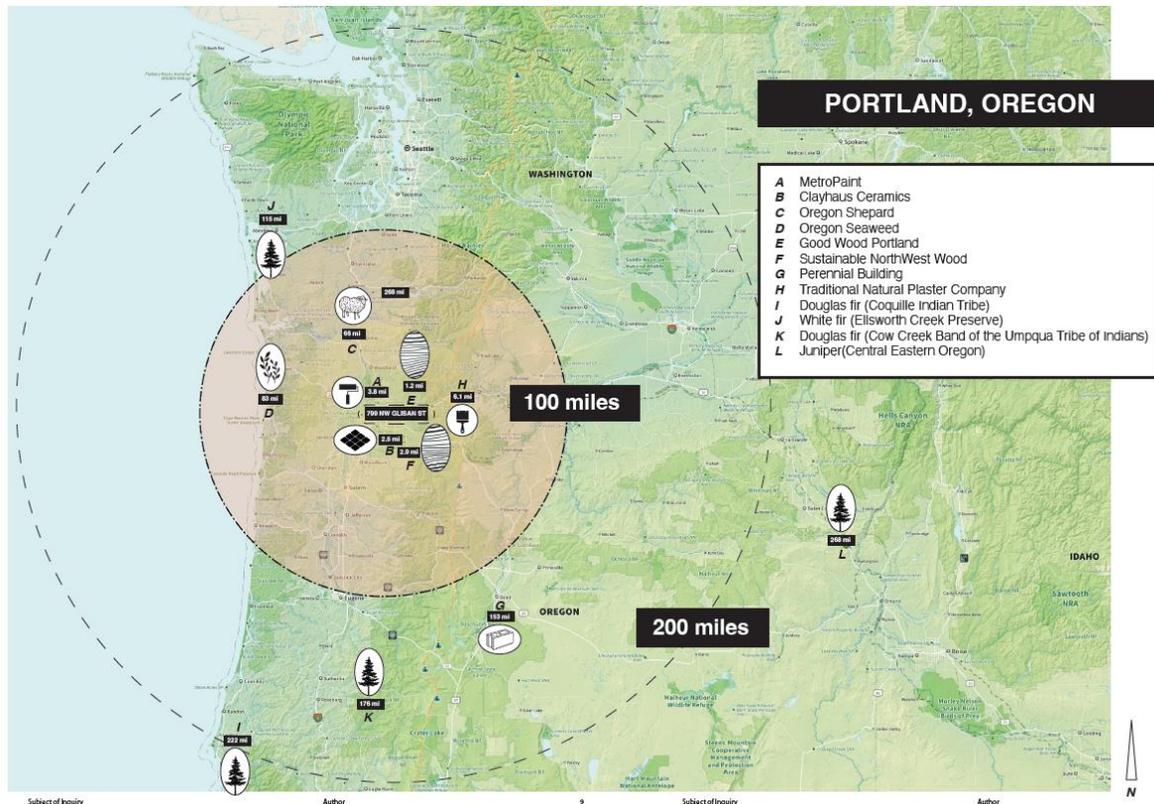


Fig. 4. Biobased material sourcing within 200 miles of Portland, Oregon. Image source: Julia Clough and Raina Mesina.

The 100-Mile Building Assembly

In the first year of the course, the hands-on workshops were essentially one-offs, but in the second iteration, biobased building assemblies were created to manifest the ideas developed in the *100-Mile Building* assignment. Working with the same partner, students designed and constructed a one-to-one scale 100-mile building assembly chunk. The *Manual of Biogenic House Sections* served as a reference for buildable and innovative assemblies.²² A College of Architecture and Environmental Design grant enabled the faculty to purchase materials for each of the five teams including wood, straw, and clay harvested near the university. The faculty dedicated two hours of class time plus two additional hours outside of class each week to support students in the construction process. The assembly incorporated a corner condition such as roof to wall, wall to wall, or floor to wall so that students could apply a range of biogenic materials in each assembly and creatively design their connections.

Outcomes of The 100-Mile Building Assembly



Fig. 5. 100-Mile Building Assembly for San Luis Obispo, California by Alyssa Lin and Ishan Singh.

In this second iteration of the course, students expressed enthusiasm about the design and learning opportunities afforded by the making assignment. The project enabled students to feel, smell, and observe the materials, thereby helping them to build confidence and excitement about using them beyond the course and in future practices. The faculty emphasized the opportunities of working with biogenic materials in designing new experiences and atmospheres so that carbon-drawdown could be viewed not just as a professional obligation, but a creative endeavor.



Fig. 6. 100-Mile Building Assembly for Seattle, Washington by Mona Burger and Melani Faber.

One team chose San Luis Obispo as the site for their 100-mile building and focused on invasive species including Eucalyptus for structure, invasive grasses for cladding, and nettle for insulation. (Fig. 5) Another team, designing for the Seattle area, found regional sources for wood shingles, hempcrete insulation, and plywood. The assembly was constructed from reclaimed shingles donated by a faculty member and wood reused from other design-build projects on campus. (Fig. 6) A third team studied biobased options for rebuilding Altadena,

California. They designed an assembly using hempcrete insulation, with an exterior finish of earthen clay and interior finishes of mycelium and hempcrete. (Fig. 7) The students' 100-mile building assemblies will be exhibited on campus to share findings with other faculty and students in the college.



Fig. 7. 100-Mile Building Assembly for Altadena, California by Aya Shadan and Efren Cabrera.

Both the investigative and making components of the 100-mile building assignment had educational rewards, but there were also logistical and other challenges. Since the course was a 10-week elective seminar and most students were in their thesis year, the students who devoted more time to their assemblies often did so because they had decided to incorporate the assembly into their thesis proposal. The more well-developed assemblies involved time outside the classroom for students and faculty.

Space was also a concern. Luckily, the college's Support Shop is large, but even with only five projects, maneuvering the models and making room for other classes took time. The type of classroom assigned (which was shared with a studio) proved essential and will be critical to the success of the course in future iterations.

Conclusion and Next Steps

A verbal survey conducted at the end of the first iteration of the course showed increased understanding of the benefits and types of biogenic and biobased building materials, but as they discovered in the *100-Mile Building Assignment*, due to the limited availability of these materials for construction, students expressed concern about their ability to design with them in practice. In a Microsoft Forms survey conducted at the end of the second iteration of the course, students expressed more optimism about designing with biobased materials. Perhaps the *100-Mile Building Assembly* assignment bolstered students' confidence. Educating future architects about the selection and performance of natural materials is critical and should be a requirement in architecture curricula, but more work needs to be done to connect agricultural and building waste streams to local building supply chains to ensure that biogenic and reusable materials are accessible to architects, engineers, and constructors. Making this shift will require policy action as well as entrepreneurship and cross-industry collaborations.

Next steps in this research, and part of the college grant that supported the course, include experimental methods to test fire, moisture, and structural integrity on 100-mile building assemblies. This work will be conducted by faculty and student assistants outside of coursework. Using regional straw, wood, clay, shells, hemp, and other biogenic materials, faculty will test the viability of assemblies for residential fire-resistive construction. Eventually, the aim is to share knowledge with local architectural practices through an exhibition and workshops that offer continuing-education credits. New and future regulations focused on biobased materials and carbon accounting will require knowledge-sharing about regional best practices and procurements. Along these lines, a faculty team also plans to host an exhibition of bioregional building designs developed by architecture student teams and practices. Showcasing and publishing

different techniques for 100-mile buildings will help to educate others about the value of regionally sourced biogenic materials and strategies for implementing this approach in architectural design and construction.

Notes:

- 1 United Nations Environment Programme (2023). "Building Materials and the Climate: Constructing a New Future." Nairobi
- 2 California AIA, "CALGreen Mandatory Measures for Embodied Carbon Reduction." *AIA California* (blog), September 5, 2023. <https://aiacalifornia.org/news/calgreen-mandatory-measures-for-embodied-carbon-reduction/>.
3. Throughout this paper, the terms "biogenic" and "biobased" are used to describe naturally derived materials. For more discussion about the nuances of these terms, see Gray, Audrey. "Biogenic & Biobased & Biosourced & Biodegradable & Biophilic & Biomimicry." *Metropolis Magazine*, Winter 2024, pp. 124–133. See also, Lewis, Paul, Marc Tsurumaki, and David J. Lewis. *Manual of Biogenic House Sections*. First edition. Novato, California: ORO Editions, 2022.
- 4 The Healthy Materials Lab. *Material Health: Design Frontiers*. London: Lund Humphries, 2023.
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17. Stathaki, Ellie. "Earthscape Studio: An Indian Architecture Studio of Elevated Simplicity," in *Wallpaper (London, England)*. December 24, 2024.
18. Rubin, Herbert J., and Irene Rubin. *Qualitative Interviewing: The Art of Hearing Data*. Thousand Oaks: Sage Publications, 1995.
19. Travis Joslyn, Phone Interview by name redacted, January 2024.
20. Carnegie Fabrics representative, Phone Interview by name redacted, January 2024.
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