Linking Digital Models, Carbon Calculators, to Advance Green Buildings

Among the human activities responsible for substantial greenhouse gas (GHG) emissions, building construction stands out as a current and rapidly growing source. According to a 2020 report, *Buildings as a global carbon sink*, up to 20 percent of the global carbon budget could be consumed by construction over the next 30 years. Against that background, the Environmental Law Institute's tenth GreenTech webinar on *Green Construction: The Future of Building* explored how potential and novel applications of existing technology—especially in wood products—can reduce commercial and residential buildings' carbon footprint along the entire supply chain.

Moderator of the March 17 webinar **Lawson Fite**, Co-chair of Marten Law's natural resources practice, kicked off the discussion by noting that going forward a creative approach to building materials can transform the sector from a stubborn GHG source into a carbon sink. "There's just huge opportunity in how we can work in this built environment together," Fite said before introducing the expert panel. Panelists were **Marta Bouchard**, Sustainability Lead for multinational software company Autodesk; **Dawn Garcia**, Marketing Communications Manager for Roseburg Forest Products; and **Kyle Freres**, Vice President of Operations, Freres Lumber Co., Inc.

Bouchard began her presentation by describing three broad factors necessitating a transformation in the architecture, engineering, and construction (AEC) fields. First, today's global population of more than 7.5 billion people will rise to 10 billion by 2050, a growth estimation that means 13,000 buildings a day must be built to meet future needs. Second, climate change is occurring globally, and the industries society relies on are major carbon emitters. Third, as we increasingly rely on technology and the economy undergoes a digital transformation, companies are seeing significant labor market effects, particularly in areas such as construction where already fewer skilled construction workers than needed today are available. We must "upskill workers and reduce the skills gap," with construction professionals who are technology-enabled and data fluent across the value chain, Bouchard said.

To address the important need and big opportunity for reducing industry emissions in the built environment, Autodesk creates software to automate how things are designed in the digital world and made in the physical world, including skyscrapers, bridges, smart cars, blockbuster films, and other products. As innovators seek more sustainable outcomes in the built environment through green construction, the AEC industry faces challenges associated with energy and carbon, climate adaptation and management, material use, and waste reduction. The construction industry's approximately 11 percent of total global carbon emissions, including from the manufacture of construction materials such as steel, cement, and glass, compares with the 2 percent emissions by the entire aviation industry. The annual operation of buildings using electricity, oil, and gas makes up another 28 percent of annual global emissions. As energy codes become more stringent, and building improvements cut energy consumption, the operational carbon footprint will shrink, but energy use is not the whole environmental footprint, Bouchard said. Traditionally, construction has employed a linear process is which buildings are designed, built, operated, and torn down at the end of their lives. But now lifecycle thinking, assessing the whole life of buildings from cradle to grave, must be applied. She emphasized “cradle-to-gate” embodied carbon, the upfront carbon generated by the materials extracted, processed, and manufactured up until a building is constructed. The “embodied carbon” is locked in place once a building is erected. Because applying sustainability as an afterthought is difficult, costly, and inefficient, it should be applied early in the planning and design process to drive sustainable outcomes.

Bouchard described several tools Autodesk has developed that bolster AEC sustainability and noted several major projects that have used the tools. The Building Information Modeling (BIM) is a holistic process of creating and managing information for a built asset. The tool integrates structured, multi-disciplinary data from all the AEC professions to give a three-dimensional digital representation of an asset across its lifecycle, from planning, to construction, to operation. Revit building design software enables sustainability analysis early in a project to assess potential energy, cost, and carbon performance. The EC3 Embodied Carbon Calculator, a free plug-in developed collaboratively with industry leaders, uses data on carbon embodied in materials to enable carbon-smart choices during materials specification and procurement. Using the EC3 tool, Microsoft’s 500-acre headquarters in Redland, Washington, cut 30 percent of the embodied carbon in the project’s supply chain. Factory OS, a San Francisco Bay Area-based modular construction company, used Autodesk’s BIM software to build safe houses 20 percent cheaper and 40 percent faster, including a 100-unit apartment building erected in 10 days.

A public policy landscape around green buildings and construction is growing daily, Bouchard noted. For example, globally, 22 nations have adopted BIM policies and governments are enacting energy efficiency and green building mandates. The European Union is evaluating a whole life emissions policy, and the United States government is launching a buy clean task force across federal projects, along with other developments.

Turning from the broad AEC perspective to a revolution occurring in the wood products industry, Garcia provided the granular perspective of one company that is using innovative technology, chemistry, and science to develop engineered wood that supports the AEC communities’ green building and sustainability initiatives. A privately held, vertically integrated company, Roseburg owns timberland, grows trees, and makes wood products with a focus on optimizing the full use of its materials. For example, when a log is cut into lumber, the branches and narrow top of the tree that are unusable for construction products are not wasted. Wood chips are used for paper, packaging, corrugated material, and as fuel in an energy plant. Sawdust, shavings, and wood debris are combined with chemistry to make durable composite products from 100 percent recycled wood.

Engineered wood, Garcia explained, basically uses thin strips of veneer peeled from a log. The veneers are stacked up, glued together with resins, and pressed and heated to make long billets that can be cut into smaller products meeting different functional and structural needs, such as headers over windows, beams, columns, and studs. Among the other uses of materials in varied applications, beautiful hardwood veneer is added to cabinetry, wall paneling, and other products. The engineered wood process is an efficient way to use raw materials without needing to use the whole tree.

Garcia summarized three decades of trends in green building. In the 2000 decade, a focus on making buildings more energy efficient inspired innovation in lighting, insulation, HVAC, and other technologies. But buildings became airtight, raising concerns about indoor air pollution, so in the 2010 decade the focus shifted to transparency about the safety of building products and measuring air quality. There was a push for environmental product declarations and life cycle assessment information, and extensive work went into creating tools like the EC3 calculator to enable comparisons of products. In this decade, the focus is much more on the embodied carbon in buildings and how choices about materials affect a building overall.

In light of the current focus, Roseburg and Freres are excited because “we have a wonderful story to tell,” Garcia said, describing various sustainable forest product certifications her company has received and her work to create a pathway for low-emitting materials to receive credit under the U.S. Green Buildings Council’s (USGBC) LEED v4.1 standard, the next generation standard for green building design, construction, operations, and performance. However, at the annual Greenbuild International Conference and Expo she learned that USGBC’s “Materials and Resources” credit category is one of the most underutilized because of the complexity of trying to achieve the credit. USGBC is looking at ways to simplify the process and to give a little more emphasis to wood products in buildings. Lastly, Garcia noted that a key element missing in the total carbon story is “the forest itself” and the circularity of wood products as a major carbon sequestration nexus.

In making its primary product of veneer, the rebranded family-owned Freres Engineered Wood that is based in Oregon achieves close to a 70-75 percent recovery factor from a log compared with the typical 50 percent factor for lumber, said Freres. Like Garcia, he provided an overview of his company’s operations and products. The company peels veneer from logs, but also uses chips, sawdust, bark, even the carbon-rich biochar byproducts from its co-generation operations that can sequester carbon in soil for thousands of years. The thin veneer pieces that are reconstructed into larger pieces of wood are engineered to perform predictably in the built environment, a critical requirement for an architect or engineer aiming to design a safe building efficiently without too much or too little material. Because products are premanufactured, they generally cut waste and reduce labor on a job site, making a building simpler to construct, with fewer connections, and with improved fire performance. Freres recounted how he went to Europe in 2015 to learn about mass timber and cross-laminated timber products and had an epiphany that these products were not a substitute for lightwood framing but for steel and concrete used in high-rise construction. That’s where the environmental and cost-benefit gains occur, he said.

Freres explained the various advantages of the engineered wood panels that are built up in one-inch sections with nine plies of veneer oriented in different directions to provide the panels’ specified performance, with a lot of flexibility in building the panels both efficiently and for particular structural purposes. Another benefit of veneer is that the knots in the wood are not cut out of the product, whereas in a board the defect might be cut out and the board finger-jointed back together. Unlike heavy timber beams that need a larger tree to cut a 24-inch column, engineered wood can create enormous products using very small trees. Freres looks for second-generation logs typically cut down for thinning operations as wildfire control. Also, unlike timber, engineered wood typically has no defects such as a knot that could be a structural problem for timber beams. Engineered wood beams do not split, twist, or warp, and engineered products have a safety factor built into their certification, which is more stringent than for glued laminated timber.

“Technology makes all this possible,” Freres said, noting that 3D BIM design is “absolutely necessary” because predesigning is required for these engineered products. He showed photographs of complex wood cuts that were made using BIM design, including a precision home stairwell and a pyramid using two-inch panels. Currently, concrete mixing at job sites is messy and requires many people and trades, in contrast with a premanufactured wall system that Freres showed for an exterior envelope in a San Francisco structure. In addition to its many environmental benefits, engineered wood is taking higher paying jobs back to Oregon along with digital skills that create more productive and meaningful work.