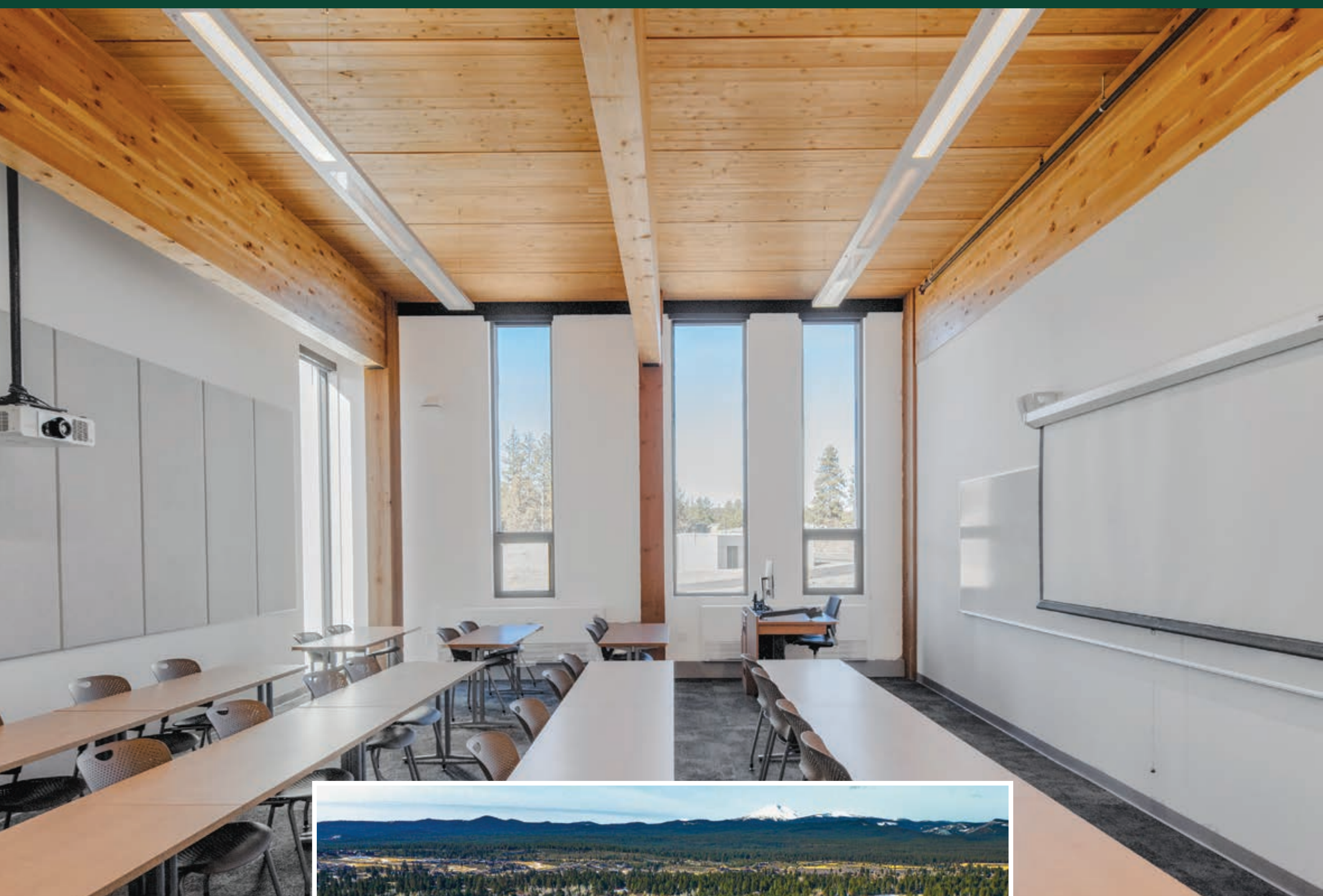
CASE STUDY

Oregon State University – Cascades
Edward J. Ray Hall

New campus building makes meaningful use of mass timber

When Corvallis-based Oregon State University (OSU) established a new campus 130 miles away in Bend, they demonstrated their commitment to becoming a model for innovation and sustainability by locating the new 128-acre campus on the site of a reclaimed pumice mine and former landfill. OSU furthered that commitment to sustainability by setting goals that new facilities meet net zero energy design standards, and by having Edward J. Ray Hall, a new building for science, technology, engineering, arts and math (STEAM), contain a 'meaningful use of mass timber.'



OSU will realize numerous long-term benefits from these requirements. The net zero energy target sets a standard for all future campus development, reducing energy use for decades to come. Mass timber building elements were manufactured using regionally sourced timber, purposefully harvested to improve the health of the forest. Using wood lowered the building's carbon footprint when compared with other materials, and prefabricated mass timber presented unique opportunities for fast, cost-effective construction. The design team also applied innovative engineering principles to optimize the structure, adding to its cost effectiveness.

Edward J. Ray Hall will serve as the prototype for OSU's future campus expansion, combining pioneering design with flexible academic spaces that can be adapted to accommodate future growth.

With seven classrooms, 12 laboratories and a mix of collaborative and quiet spaces, Edward J. Ray Hall was built to house classes for the university's rapidly growing STEAM programs. The four-story structure is fronted by an open, cascading plaza that will eventually lead to other campus buildings.

In 2019, OSU sponsored a design competition for the project as part of the architect selection process. Understanding that the use of mass timber was an important requirement, SRG Partnership proposed a hybrid structure—steel beams and columns with cross-laminated timber (CLT) decking—assuming it would be the least expensive.

But when Swinerton joined the project team, they demonstrated that an all-mass timber structure would cost less. "Our company has done nearly 30 mass timber buildings, so we understand that its advantages come through smart design and knowing how to take advantage of prefabrication and construction efficiencies relative to other trades," said William Silva, Swinerton's Director of Preconstruction.

The design evolved to a glulam post-and-beam frame with CLT floor and roof panels, based on a modular grid to allow future modifications. "OSU had three specific requirements: they wanted a flexible and adaptable structure, a meaningful use of mass timber, and a net zero energy-ready building," said Lisa Petterson, a Principal with SRG. "We initially wondered how we could afford to do it all, but were surprised and pleased to learn that a full mass timber frame would be less expensive. In the future, our first go-to design option will be an all-mass timber system."

Requirements for Flexibility and Adaptability

OSU Cascades has a small but growing campus, so they needed the building configured to serve multiple functions. They also wanted the flexibility to change how areas of the building are used—for example, by someday converting classrooms to lab space. And for budget purposes, they wanted to optimize the spanning capabilities of the mass timber deck. All of this meant they had to find the optimal grid configuration.

After evaluating multiple layouts and weighing column spacing against material volume in terms of CLT panel thickness and beam sizes, they landed on a 10x32-foot grid for the classroom spaces with a 10-foot-wide corridor running down the middle of the building.

"SRG has done a lot of laboratory buildings, so we knew that having at least a 30-foot clear span for classrooms was going to be helpful," said Petterson. "The 10-foot spacing in the other direction also allowed us to take full advantage of Vaagen's 60-foot CLT panels. Since we decided to use a concrete topping slab for the diaphragm and to manage

PROJECT DETAILS

OSU Cascades – Edward J. Ray Hall

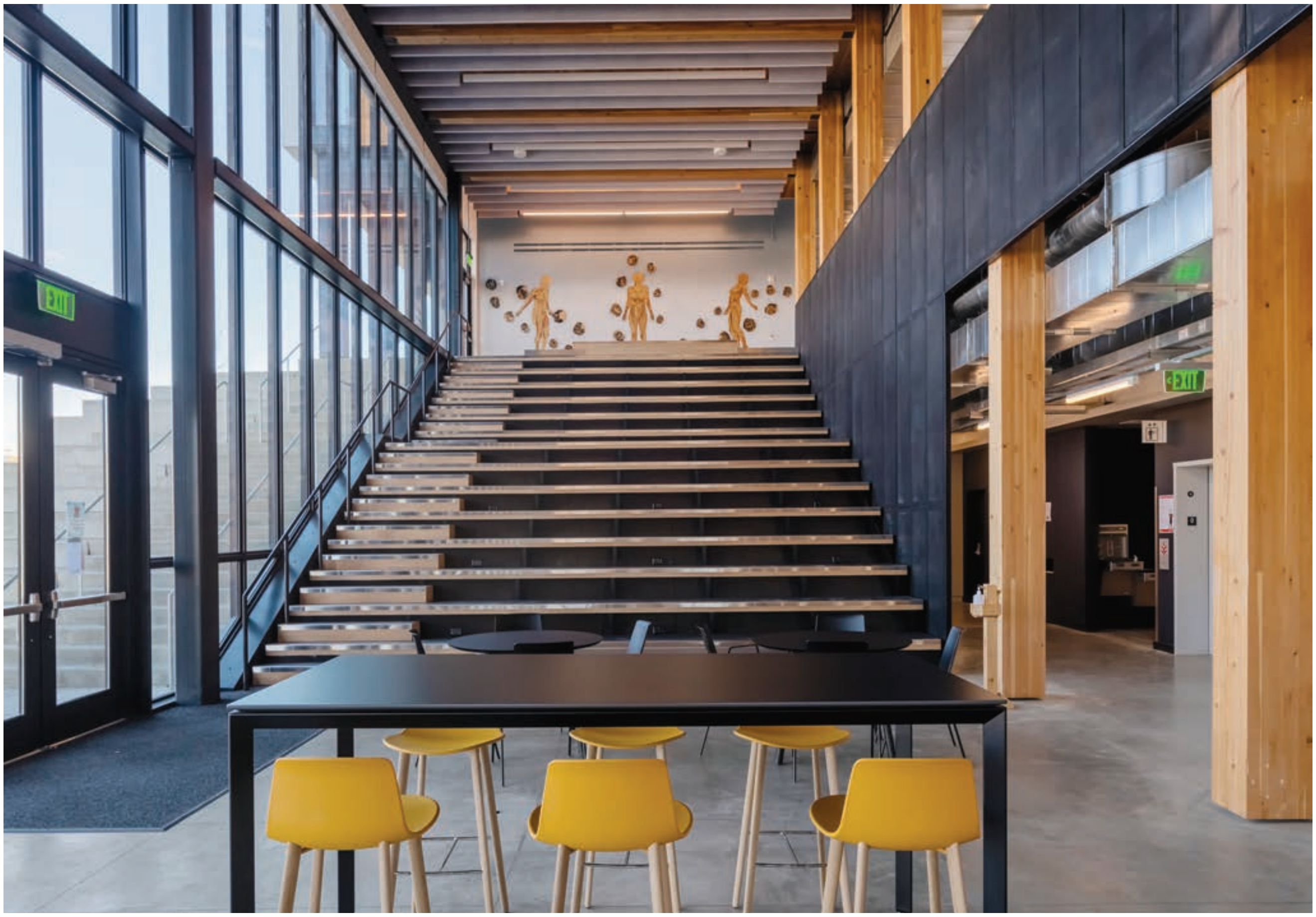
LOCATION:	Bend, Oregon
STORIES:	Four stories
SIZE:	50,000 square feet
CONSTRUCTION TYPE:	Type III-B
COMPLETED:	2021

PROJECT TEAM

CLIENT/OWNER:	Oregon State University
ARCHITECT:	SRG Partnership, Inc.
STRUCTURAL ENGINEER:	catena consulting engineers
GENERAL CONTRACTOR:	Swinerton
MASS TIMBER TRADE PARTNER:	Timberlab (detailing, timber stair fabrication, installation)
MASS TIMBER SUPPLIERS:	Vaagen Timbers (CLT; glulam fabrication)
	Freres Engineered Wood (mass timber stairs)

Connect with the OSU Cascades – Edward J. Ray Hall project team at *https://www.woodworksinnovationnetwork.org/projects/91*

WOODWORKS INNOVATION NETWORK



vibration, we found we could step down from a 5-ply to a 3-ply stress-rated CLT panel, which provided a significant cost savings—between $5 and $10 a square foot. This reduced the overall building weight as well, which cut the amount of concrete the building needed for shear walls and foundations."

The layout also eliminated the need for perimeter girders, which allowed windows to extend to the underside of the CLT floor above, bringing daylight further into the rooms. Classrooms have no drop ceilings; the major mechanical systems run through the corridors. Air ducts feed from the corridors into the rooms but do not extend through the rooms, minimizing visual impact and leaving the CLT ceilings fully exposed to the spaces below. Plumbing and electrical conduits for lab requirements such as fume hoods and lighting were run through the concrete topping slabs of the floors above and routed down through the CLT panels, both for a clean aesthetic and future flexibility.

"For us, it's not just about being flexible and adaptable today," said Steve Pitman, Director of Facilities and Operations for OSU Cascades. "It's about having buildings that we can reconfigure in 15 or 20 years as our educational requirements change. This structural system gives us the ability to do that."

E-Rated CLT Panels

One of the keys to cost savings with the Edward J. Ray Hall project was the design team's use of E-rated CLT panels. Panels with a grade of E1 through E5 are manufactured using machine stress-rated (MSR) lumber for longitudinal layers (layers parallel to the major axis) and visually-graded lumber for transverse layers. This differs from CLT grades V1 through V5, which use visually-graded lumber for both longitudinal and transverse layers.

"Because the strength properties have been mechanically measured and verified, we know the minimum engineered properties of each piece of MSR lumber," explained Russ Vaagen, CEO of Vaagen Timbers. "This means that an E-rated CLT panel has more predictable strength and stiffness properties, which means better vibration performance. Even though they were thinner, the E-rated panels for Edward J. Ray Hall could span further."

Making the Most of the Forest Resource

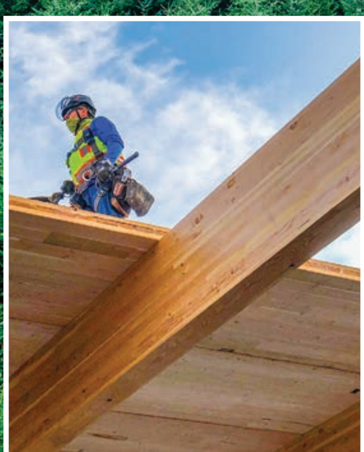
Forest management played an important role in the makeup of the CLT used for Edward J. Ray Hall and added to the environmental story so important to OSU Cascades.

Lumber used to produce the panels came from Vaagen Brothers Lumber, an independent mill that specializes in processing small-diameter logs primarily harvested from thinning and other forest restoration operations. The logs are cut into dimensional lumber—2x4s and 2x6s—and turned into mass timber products like CLT.

“This means our CLT is really a byproduct of forest restoration efforts,” said Russ Vaagen. “Our selective harvest methods improve the forest; removing small trees and dense undergrowth leaves more room for larger trees to grow, creating a healthier forest that is better able to survive forest fires and disease.”

Thousands of acres of inland northwest forests, including those on private, state, federal, tribal and family forest lands, have been destroyed by wildfires in recent years, making active forest management and thinning operations more important than ever.

How important? The project team worked with forest product experts to measure the impact on forest health and jobs created as a result of the wood products used for Edward J. Ray Hall. They found that more than 60 acres of improved forest health can be attributed to this one project, which created and supported jobs in seven Washington and Oregon counties.



Silva added, “Our ability to go with a 3-ply CLT panel was driven in part by our decision to run four inches of structural concrete topping on top of the slab. When we played with the bay spacings, we learned that the 10-foot span worked with a 3-ply panel if the panel was E-rated. This optimized the fiber within the structural frame while still meeting the layout needs of the classrooms, labs and other spaces within the building.”

Sustainability Goals

OSU Cascades has ambitious sustainability targets for their long-range development plans, and they wanted the design of Edward J. Ray Hall to set the standard for future campus buildings. The project team approached the challenge by:

- Specifying a renewable, sustainable building material. Using mass timber reduced the embodied carbon of the structure when compared with other building materials like steel or concrete.
- Setting net zero energy, water and waste goals and using best design practices to reduce the operational energy needs of the building.
- Limiting solar heat gain by orienting the building in an east-west direction, adding large windows with vertical shading devices and broad overhangs to protect the interior from sun in this high-desert location.
- Powering the building using geothermal energy, with a groundwater-based exchange system that connects with an aquifer 500 feet below the surface. This system will provide year-round heating and cooling for the entire campus.
- Optimizing the building envelope for energy efficiency, taking advantage of CLT’s thermal mass and balancing the heating and cooling system options against the glazing percentage.
- Taking advantage of daylighting so that most classrooms can be used without electrical-powered lighting during the day. The structure was designed with no perimeter beams, which allowed windows to extend higher, bringing daylight further into each room.

“Improved daylighting was critically important in our ability to deliver a net zero energy building, and mass timber helped us maximize the glazing area,” said Silva. “The mechanical distribution systems also fit well within the mass timber layout, and the fact that mass timber has thermal insulating properties helped improve our envelope rating. There are so many strategies we can use when we take advantage of mass timber’s benefits.”

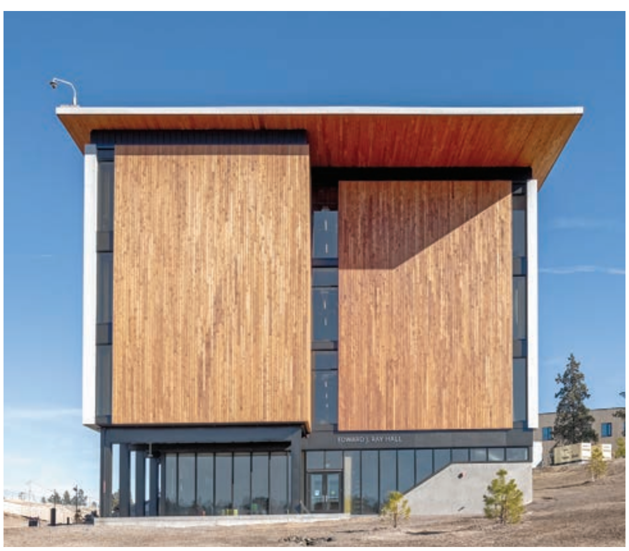
Creating Healthy Forests

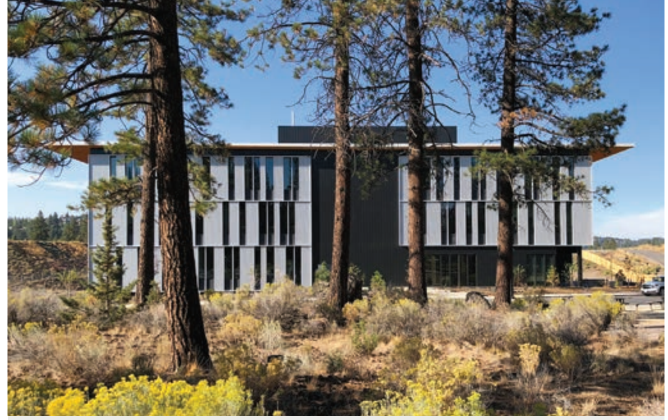
Communicating a positive story about timber harvesting can be challenging. And while some designers turn to certified lumber for assurances of sustainable sourcing, there are other options.

"We think it's a fair question when people ask how cutting trees can be good," Vaagen said. "We lean into that by letting them know Edward J. Ray Hall is helping to create a healthy forest. It's taken trees that might otherwise have released their carbon in a wildfire and put them in a building in Bend, Oregon—storing the carbon, and giving students a building they'll enjoy for decades. So, this is a good sustainability story."

SRG's Petterson added, "We learned from this project as well—that mass timber provides so many benefits in terms of constructability, biophilic design, net zero energy goals, and more. I've been an architect for almost 30 years; this is my first fully completed mass timber project and I don't ever want to go back."

In addition to setting a standard of sustainability for the campus, OSU wanted a building where students felt comfortable to linger after class. "Mass timber helped us elegantly and efficiently create a warm and inviting space, in a way that steel and concrete could not," said Pitman. "But we also needed this building to be functional and built within our limited budget. It was a multifaceted challenge to pull all that off. And looking back on it now, I couldn't be more pleased with how it turned out."





OSU Cascades – Edward J. Ray Hall

Volume of wood products used:
71,645 cubic feet

U.S. & Canadian forests grow this much wood in:
6 minutes

Carbon stored in the wood:
1,803 metric tons of CO_2

Avoided greenhouse gas emissions:
697 metric tons of CO_2

TOTAL POTENTIAL CARBON BENEFIT:
2,500 metric tons of CO_2

EQUIVALENT TO:

529 cars off the road for a year

Energy to operate 264 homes for a year

Source: US EPA

Estimated by the Wood Carbon Calculator for Buildings, based on research by Sarthre, R. and J. O'Connor, 2010, A Synthesis of Research on Wood Products and Greenhouse Gas Impacts, FPInnovations. Note: CO_2 on this chart refers to CO_2 equivalent.

Reducing Carbon Footprint

The use of wood lowers a building's carbon footprint in two ways. Wood continues to store carbon absorbed by the trees while they were growing, keeping it out of the atmosphere for the lifetime of the building—longer if the wood is reclaimed at the end of the building's service life and re-used. Meanwhile, the regenerating forest continues the cycle of carbon absorption. Wood products also require less energy to produce than other building materials, and most of that comes from renewable biomass (e.g., bark and sawdust) instead of fossil fuels. Substituting wood for fossil fuel-intensive materials is a way to avoid greenhouse gas emissions and reduce embodied carbon.

Funding provided in part by the Softwood Lumber Board
WoodWorks is an equal opportunity provider.

Photos: SRG Partnership, Inc.; Swinerton (construction images); Plum Creek (forest image)
