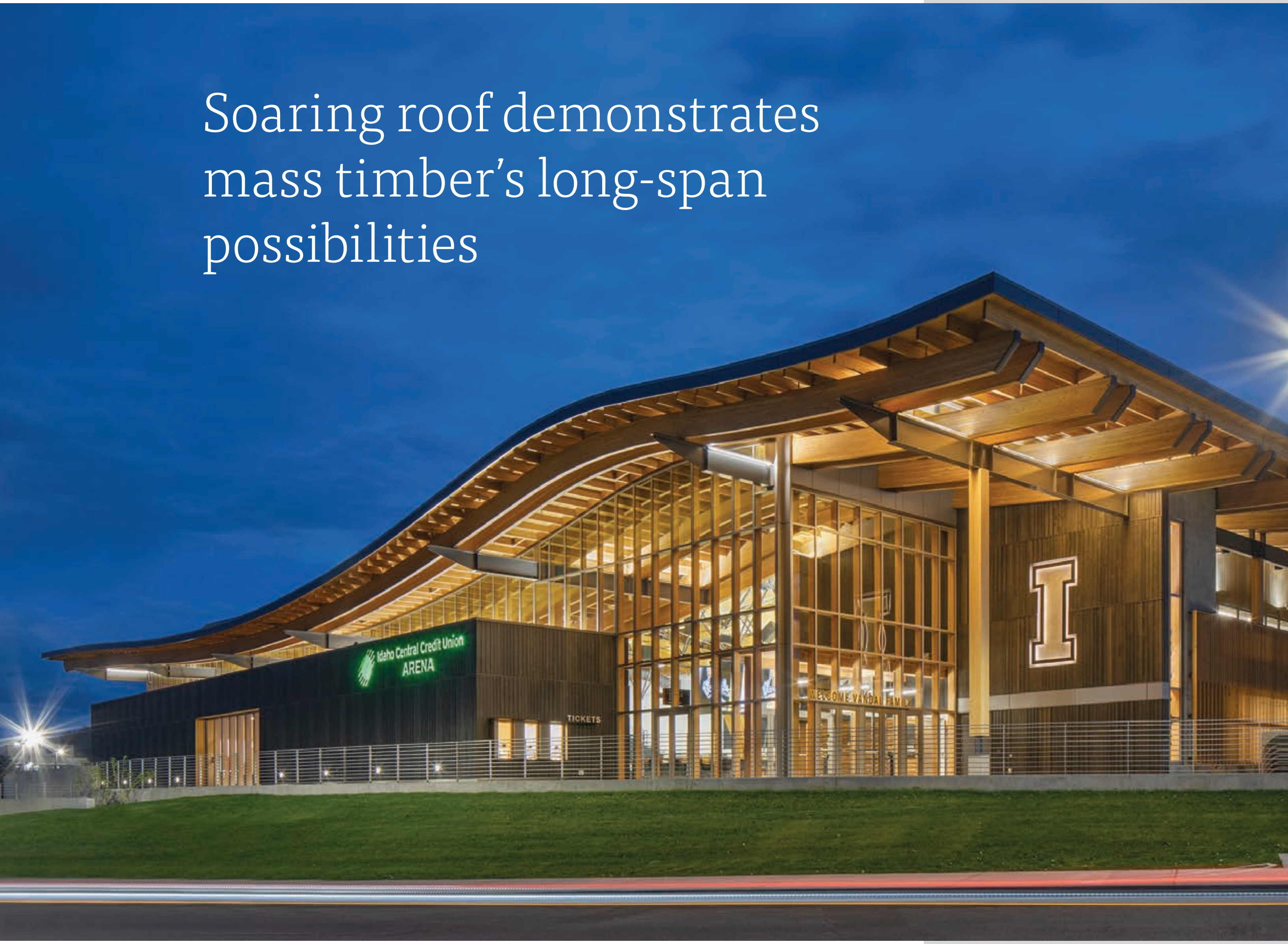
CASE STUDY

Idaho Central Credit Union Arena



While taller mass timber buildings continue to capture worldwide attention, the University of Idaho chose to pursue a different type of innovation with the Idaho Central Credit Union (ICCU) Arena by showcasing wood's impressive long-span capabilities. Inspired by the rolling hills of the nearby Palouse, the undulating wood roof of this sports and events facility soars over the open space below, creating a visually stunning structure not typically associated with large arenas.

This project is also unique in that it was built through a collaboration of Idaho stakeholders, using wood harvested from the University of Idaho's Experimental Forest, made into glue-laminated timber (glulam) beams by Idaho manufacturers. "The complex structure makes a strong statement, not only for what mass timber can do, but also for what Idaho's timber industry can do," said Lucas Epp, Vice President and Head of Engineering for StructureCraft.

PROJECT DETAILS

Idaho Central Credit Union Arena

LOCATION:	Moscow, Idaho
STORIES:	Three stories
SIZE:	66,186 square feet
CONSTRUCTION TYPE:	Hybrid: Type II-A / Type IV-HT
COMPLETED:	2021

PROJECT TEAM

CLIENT/OWNER:	University of Idaho
ARCHITECT:	Opsis Architecture
ASSOCIATE ARCHITECT:	Hastings+Chivetta
STRUCTURAL ENGINEER:	KPFF Consulting Engineers | *Base Building* StructureCraft | *Roof Structure*
CONTRACTOR:	Hoffman Construction Company
MASS TIMBER FABRICATOR AND INSTALLER:	StructureCraft
GLULAM SUPPLIERS:	Boise Cascade QB Laminators

Connect with the Idaho Central Credit Union project team at *www.woodworksinnovationnetwork.org/projects/477*

WOODWORKS INNOVATION NETWORK

A towering wood roof structure, formed using more than 800 Douglas-fir glulam beams, sets an exciting tone for the 4,000-seat ICCU Arena, home to the University of Idaho Vandal men's and women's basketball teams.

"We wanted to prove that you can build this type of facility using wood," explained Guy Esser, Architectural Project Manager for the University of Idaho's Facilities, Architectural and Engineering Services. "During the process, the project ended up being a teaching tool—a learning laboratory for forestry and engineering students—and a demonstration for the community on the value of Idaho wood products."

The mass timber structure was engineered with an innovative system designed to meet the complex loading requirements of the long spans and double-curved roof design. The roof is supported at the building's midpoint by a massive portal frame constructed of glulam beams. It also includes 14 king-post trusses, curved and shaped to create the rippling form of the roof. The 140-foot-long trusses, spaced 14 feet 6 inches apart, were built with double glulam top chords and steel king posts. Two layers of plywood form the roof deck, and more than 400 roof panels were prefabricated and lifted into place during installation.

The facility also includes a practice court and a three-level structure housing locker rooms, coaches' offices and the alumni center, built using a conventional glulam post-and-beam system. Dowel-laminated timber (DLT) panels form the floors in the alumni center and cross-laminated timber (CLT) panels frame the entry vestibules into the building. Because designers wanted visitors to see wood in every element of the building, even the arena's corner bench seats are made of curved laminated wood.

"Most focus on mass timber in the U.S. has been about going vertical," said Chris Roberts, Associate Principal at Opsis Architecture. "But our challenge with this arena was to span long distances and maximize open space. It's natural to expect to see concrete and steel in an arena, but we used mass timber to create a beautiful wood structure that reflects Idaho's sense of place, creating a unique experience for the people inside."

Idaho Timber Collaboration

The ICCU Arena celebrates Idaho's forestry heritage and shows visitors what's possible using mass timber construction. "Forests, forestry and forest products have been an important part of the University's mission from its founding in 1889, and this continues today," said Kurt Pregitzer, Retired Dean and Professor Emeritus at the University of Idaho's College of Natural Resources. "Arguably the most sustainable building material known to man, wood was a natural choice for this project."

Wood Innovations Grant

In 2017, the Arena project team received a Wood Innovations Grant from the USDA Forest Service. Tom Gorman, Professor Emeritus of Renewable Materials for the College of Natural Resources at the University of Idaho, said the grant helped fund innovative aspects of the building that may not have otherwise been possible to explore. "The result is not only a beautiful facility that will help attract events to Idaho, but a structure that will serve as a national model for the long-span use of mass timber in sports facilities."

Sustainability was intricately wrapped into the mission of using wood. “We require that all new buildings on campus meet minimum LEED Silver; usually the goal is LEED Gold,” said Esser. “But with this project, we decided to go above and beyond, which led to a discussion about trying to use as much timber sourced from Idaho as possible.”

Life Cycle Assessment

In keeping with the project’s educational and sustainability goals, architecture students from the University of Idaho are compiling data to undertake a life cycle assessment (LCA) of the structure. They are carrying out the analysis with verification from the USDA Forest Products Laboratory and the Athena Sustainable Materials Institute.

About 80 percent of the wood fiber came from University of Idaho forestlands. Idaho Forest Group milled the logs into dimensional lumber, and Idaho-based Boise Cascade and QB Laminators fabricated the glulam beams. The collaboration even involved the Idaho Forest Products Commission, which challenged University of Idaho students with a competition to submit design ideas for the new arena.

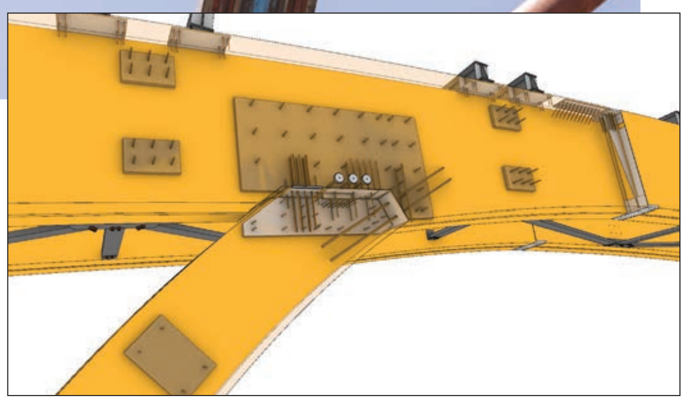
“It was a unique experience for us,” Roberts said. “I’ve never been involved in a project where we were so closely linked to everything ranging from where the trees were grown to where the timber was placed within the building. The collaboration with the Idaho timber industry was extraordinary.”

Unique Path for Code Compliance

The International Building Code doesn’t explicitly allow a hybrid structure of this use type, so the design team took an alternate means and methods path to achieve compliance. They categorized the project as Type II-A and Type IV-HT construction, leveraging both to allow the flexibility needed to design the structure. “Both Type II-A and Type IV construction carry similar allowances regarding number of stories and allowable area,” explained Roberts. “Therefore, the non-combustible components were designed to meet Type II-A construction, and the combustible components—the mass timber elements—were designed with the intent of meeting Type IV requirements. We simply took advantage of the performance nature of each construction type without all the prescriptive requirements.”

Fire Modeling

The hybrid construction type also impacted fire modeling since steel components were used in the roof’s king post trusses. Opsis worked with fire and building safety consultant Jensen Hughes to consider fuel loads for the steel members at various points within the arena. “Fire modeling allowed us to consider heat transfer calculations within the structural analysis,” said Roberts. “We were able to show that under a 1-hour scenario, wood and steel members would not reach any critical failure temperatures.”



Credit: StructureCraft

Distinctive Building Features

The ICCU Arena contains several unique mass timber elements.

Portal Frame

A proscenium arch delineates the space between the main court and practice gym. To allow for extended seating, the structural frame was required to span across the entire arena while maintaining a view corridor for spectators. After multiple architectural and structural iterations, Opsis and StructureCraft landed on a unique design for the portal frame, using glulam columns and steel tie rods to cantilever the main glulam beams out to a central drop span.

King post trusses span up to 140 feet between supports at either end of the arena onto this centrally located portal frame, resulting in heavy loads on the frame.

StructureCraft's Epp said that more than 115 feet of tributary area is supported on the 120-foot clear span of the massive arched glulam portal frame. "That's 450,000 pounds of load coming down each of the four legs, so we designed a special thrust block connection that uses a steel plate between the column and beam to transfer that huge load."

Since spectator visibility of the performance court was important, StructureCraft bowed the columns and positioned the portal frame feet to maintain a view corridor for spectators. And because they wanted to protect the visual experience of the exposed mass timber roof, they spread the top chords of the portal frame arch apart by nearly five feet and hid a large mechanical duct, big enough to walk through, between the beams. The duct—the design team called it their utility highway—was pre-assembled within the portal frame and lifted into place in one piece. Installers then ran secondary ductwork from the portal frame through the double top chords of the trusses, keeping the mechanical systems nearly hidden from view for a clean aesthetic.

"It was exciting to see this giant portal frame being flown into place," Epp said. "The 500-ton crane was making up to 40,000-pound picks and setting it all into place. Because this project was so complex geometrically, it reinforced our belief in the fact that collaboration, 3-D modeling and prefabrication were all critically important to successful installation."

King Post Trusses

Fourteen king post trusses march across the roof, each with a unique geometry to create the sweeping waves which make the ICCU Arena so distinctive. Each truss was created using a double glulam top chord with steel web elements and a steel bottom chord. The design team concealed secondary mechanical systems between the top chords, leaving visual focus on the dramatic mass timber structure.

Additional complexity came from the undulating curvature of the roof itself since each truss has a unique geometry. “We quickly determined that we could not afford to have all the beams uniquely manufactured,” Epp explained. “So, we found a way to rationalize the geometry and limit the number of unique radii to control both cost and schedule by changing the length of the top radius of each glulam truss chord pair.” This meant the arc’s tangent comes off at a different angle for each truss, giving the perception that the roof has a double curve. Each pair of glulam truss chords is comprised of a series of arcs and straight lines of various lengths. StructureCraft connected the beams end-to-end using splice joints to form the 140-foot-long truss chords.

The solution was both customized and optimized, Epp said. “The radii were repeatable, which simplified beam manufacturing, but the lengths were all different. We brought all the glulam up to our manufacturing facility outside of Vancouver, BC, scribed each member and test fit every connection to ensure that truss installation would go smoothly.”

The trusses span further on one side of the portal frame than on the other, adding even more complexity to the engineering. StructureCraft engineers offset the pin connection from the center of the portal frame to account for the difference in load magnitudes on each side.

Epp says that their use of computational design and engineering throughout the project was key to success. “We developed unique parametric models of both the portal frame and the king-post trusses, allowing us to optimize the geometry, minimize glulam volumes where possible, and meet all Arena requirements—such as height requirements between the court and the roof, and maintaining view corridors from the seating in the practice gym.”

Composite Plywood Roof Deck

Type IV construction permits tongue-and-groove planks not less than two inches in nominal thickness, or 1-1/8-inch wood structural panels with exterior glue. But neither of those would have adhered to the curves of the roof. “So together with StructureCraft, we came up with a sandwich plywood panel—5/8-inch and 1/2-inch panels mechanically fastened together,” said Roberts. “While the overall monolithic thickness met the prescriptive structural requirements, we had Jensen Hughes do a hazard analysis and fire modeling to ensure that the composite panel would still perform and meet the 1-hour fire exposure requirements.”

Roof panels were prefabricated at StructureCraft’s facility with just one layer of the plywood, shipped to Idaho and installed. The second layer of plywood was installed on site to create continuity of the structural diaphragm.

Lateral Design

While the roof structure looks like an exploration in geometry, the overall structural system used an ordinary concrete shear wall system for lateral support, with two concrete stair cores, two concrete shear walls, and steel brace frames.

The base connection of the portal frame transferred both axial and lateral loads. "It's not immediately apparent, but since the portal frame is an arch, we also have lateral shear at the bottom of each leg," Epp said. "So, there aren't just vertical loads, but huge lateral loads in that portal frame. We worked closely with KPFF to design a giant steel shear key to drag that load down into a concrete tie beam."

Collaborative engineering was a big part of their success. KPFF focused on the net distribution of the forces and overall stiffness while StructureCraft considered shear transfers and portal frame impact. They used plywood for the diaphragm, which extended from the concrete shear walls on one end of the building to the steel bracing on the other, a span of almost 275 feet. The second layer of plywood was installed on site using fully threaded screws to resist wind uplift.

Protecting the Wood

Hoffman Construction has worked in the Inland Northwest for decades, so they were familiar with the unique challenges of temperature and weather in the region. "That's why the entire project schedule was built around getting the roof installed before winter," said David Shourd, Project Manager. "As StructureCraft laid in roof panels, we were right on their heels installing the vapor barrier. Most of the wood never saw a single rain event."

As extra insurance, StructureCraft applied low-VOC protective coatings to all wood members during fabrication for dimensional stability, and to protect the wood from UV degradation and moisture absorption. "We all worked together to develop a conditional-based coating plan," Shourd said. "For example, wood installed at ground level, where people can touch it, has multiple coats, as did wood exposed to the exterior. Wood used in more protected areas had fewer coats."

But protection didn't end with coatings. Winters in Moscow, Idaho are cold and dry, and once Hoffman enclosed the building, they pumped in heat to continue interior work, which made the air even dryer. "While wood checking is purely aesthetic and not a structural concern, we still wanted to protect the timber," said Shourd. "So, we brought in swamp coolers to add moisture back into the air, to help the wood hit equilibrium more slowly, and then monitored moisture for weeks. It was a location-based challenge for sure, but one we needed to overcome. And since the University of Idaho is my alma mater, I want to keep this arena looking good."

Idaho Central Credit Union Arena

Volume of wood products used:
49,866 cubic feet

U.S. and Canadian forests grow this much wood in:
3 minutes, 21 seconds

Carbon stored in the wood:
1,231 metric tons of CO_2

Avoided greenhouse gas emissions:
509 metric tons of CO_2

TOTAL POTENTIAL CARBON BENEFIT:
1,740 metric tons of CO_2

EQUIVALENT TO:

368 cars off the road for a year

Energy to operate 184 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 sequester 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.

Game Changer

Innovative design, long spans, complex geometry, regional collaboration—the ICCU Arena has it all.

"It's rare to work on a project where you get to create and innovate in such a collaborative process like the team did here," said Epp. "This building expands the horizons of what's possible with mass timber and shows that there are pragmatic ways to build a complex structure like this."

Roberts added, "Wood is not the first material that comes to mind when you think of arena construction. Most people expect concrete and steel. But everyone who enters this building—athletes, fans, and visitors—will think differently now."

The positive experience will continue for the University overall. "It's a game-changer for our basketball programs," said Esser. "Better recruiting, better fan experience for sure. But it's not just about basketball. This facility is for everyone. It's a university asset. It's a community asset. It's a state asset."

Pregitzer added, "We wanted a legacy outcome that would demonstrate to the thousands of people who utilize the arena how important, beautiful and useful wood is to our state. We have shown how wood can be used to build a sustainable future for Idaho."

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

Photos: Lara Swimmer — pgs. 1, 2 (top), 4, 7 (top); University of Idaho

