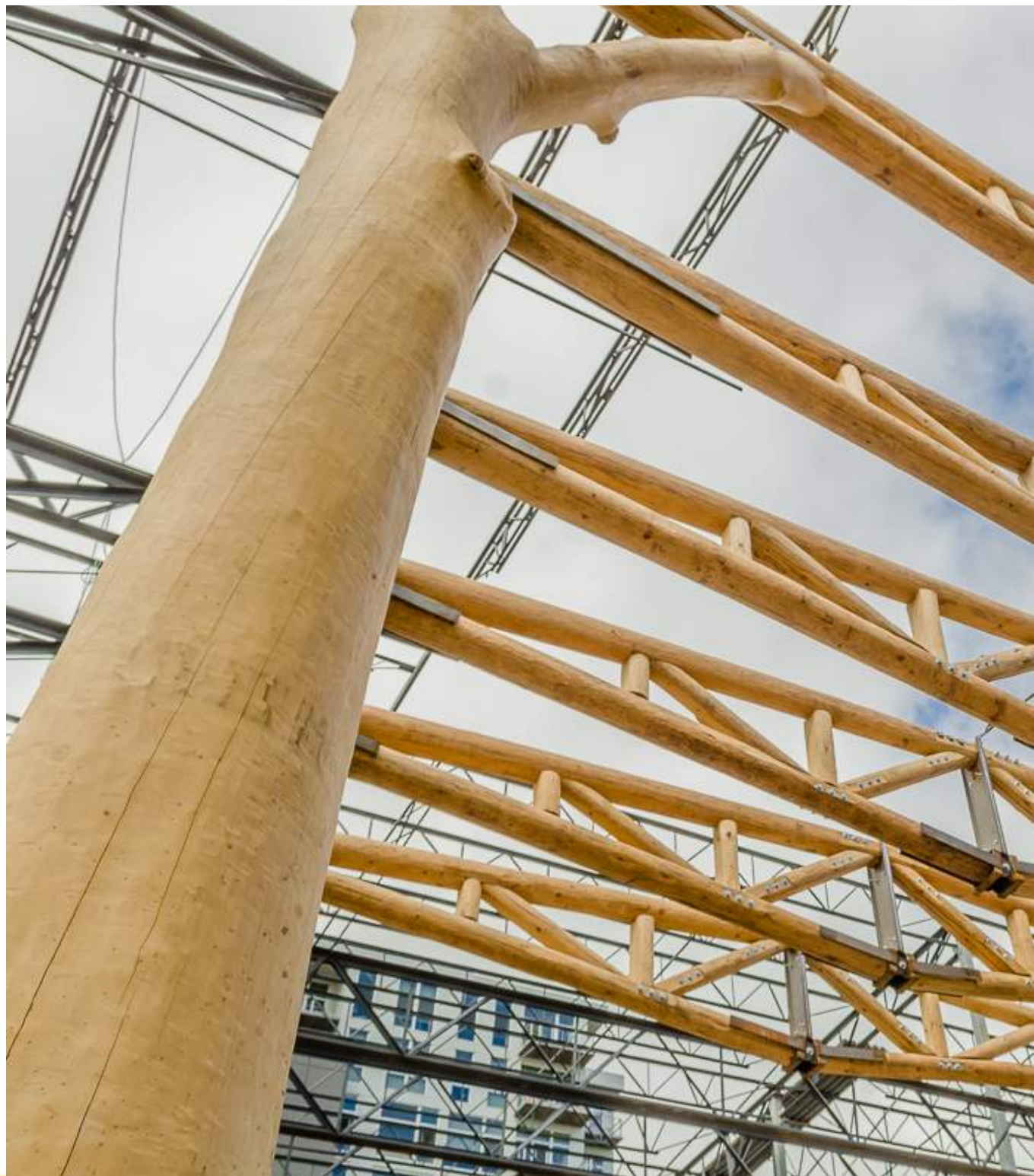


Why Trees are Stronger than Wood

AIA Provider #: 40107651
Course #: WTST002

GBCI: 0920003324



Course Description

THESIS:

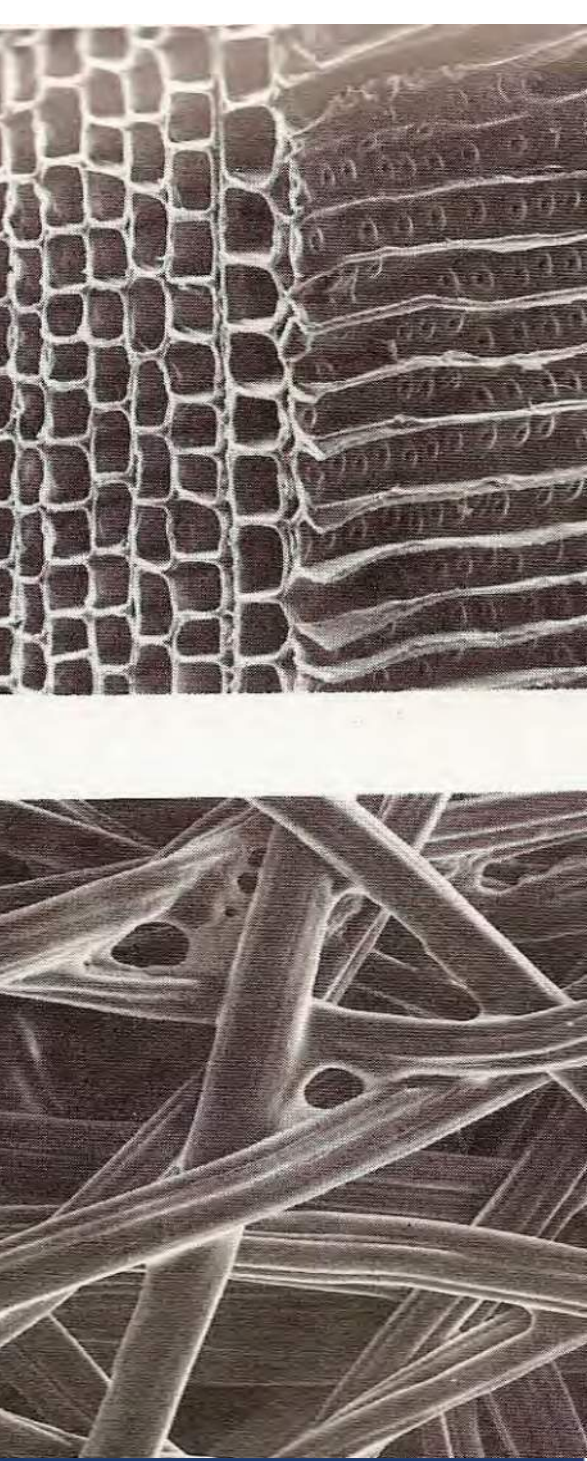
- Building with small-diameter timber from forest management cullings is now a viable structural material available to commercial construction nationally.

FACTS PRESENTED:

- Historical and modern examples of round timber and mass timber (cross-lam) construction demonstrate the variety and durability of building with wood.
- Material science demonstrating the competitiveness of round timber in load capacity, bending strength, fire rating, and life cycle performance.
- Information on the declining health of forests and lessons learned from managing a 134-acre Forest Service Council sustainable forest and learning lab.

CONCLUSION AND RECOMMENDATION:

- Incorporating small-diameter timber, a material that is considered a byproduct of sustainable forest management, into commercial and residential construction will have a restorative impact on communities and the built environment.



Imagine...

- **Self-replicating carbon nano-fibers** that clean the air while being produced.
- The inputs are **air, water, and sunlight**.
- **50% stronger** in bending than milled wood of the same size.
- A **weight to strength ratio** equal to steel in tension.
- **Code-compliant**, definable as Heavy Timber in the IBC.
- Quantifiable structural performance in **industry-standard engineering** workflows.
- Over **200 million** years of structural testing and material optimization.

New Markets for Unmilled Cull-trees

**Product Development
Inventory and Sales Software
Manufacturing Capacities**





Construction contributes 23% of total CO2 emissions produced by global economic activities.

Using wood building products could save 14-31% of global CO2 emissions.

Investing in forests is an insurance policy for the planet.

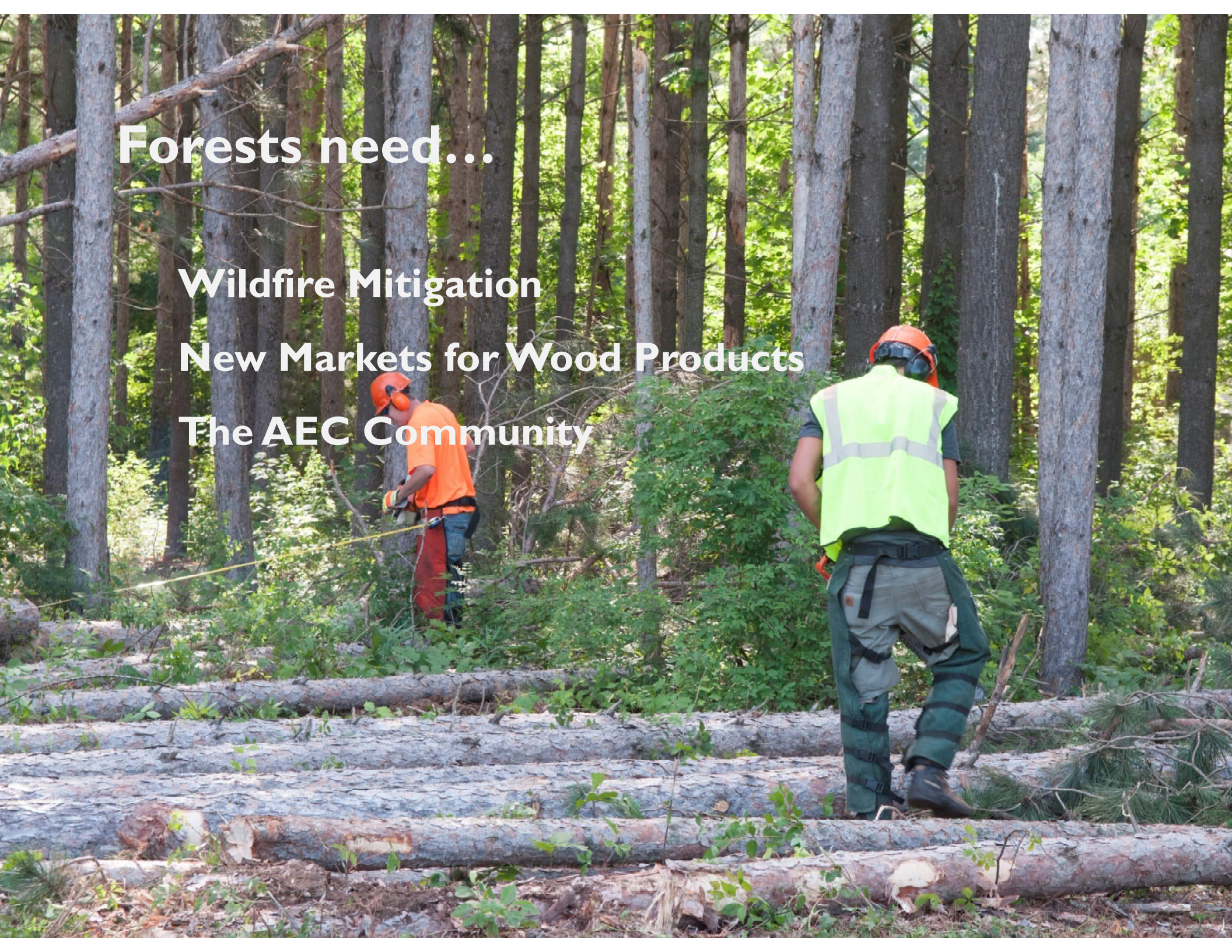
-United Nations Secretary-General Ban Ki-moon

Forests need...

Wildfire Mitigation

New Markets for Wood Products

The AEC Community

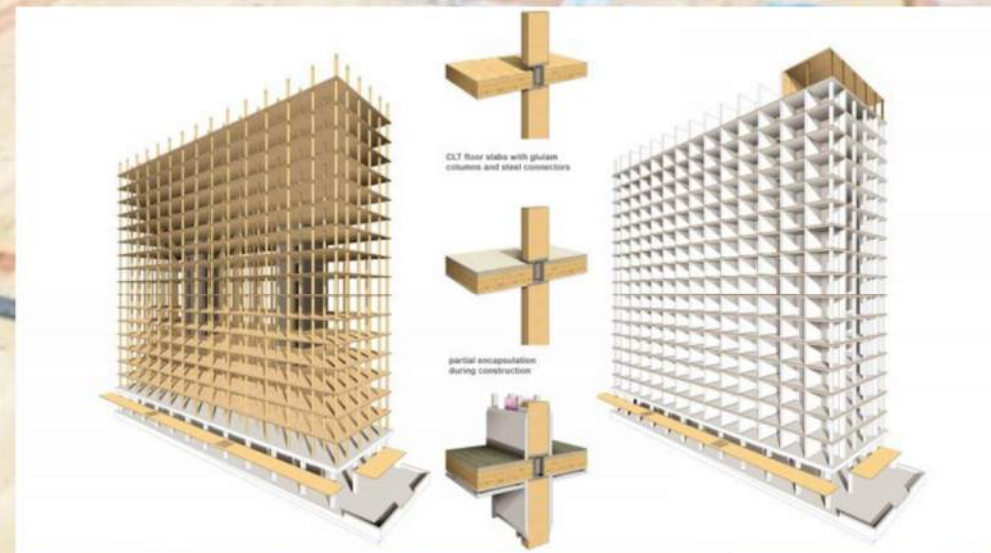


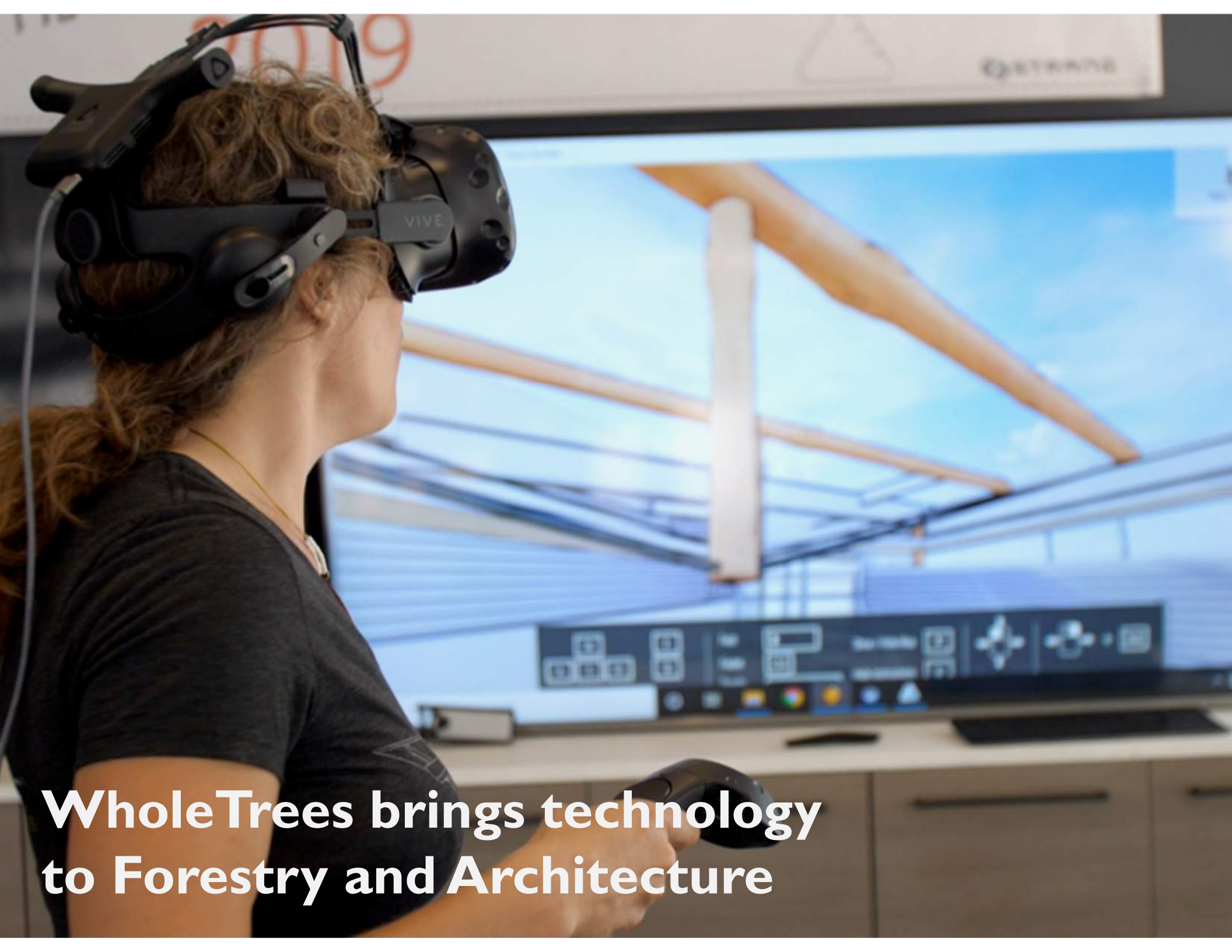
The AEC Community wants...

Health, Wellness and Delight

Affordable, Authentic, Green Solutions

Wood





**WholeTrees brings technology
to Forestry and Architecture**

Trees: The Original Skyscraper



"Whereas modern engineered lumber exemplifies the architect's will to eradicate all material unpredictability and inconsistency, Japanese architecture was tightly managed with material selection and prefabrication."

**Architect Magazine
June, 2016**

1400 Years Old
Seismic Zone 4

Wooden Skyscrapers: Cross-Laminated Timbers (CLT)



Column, Floor and Wall Systems



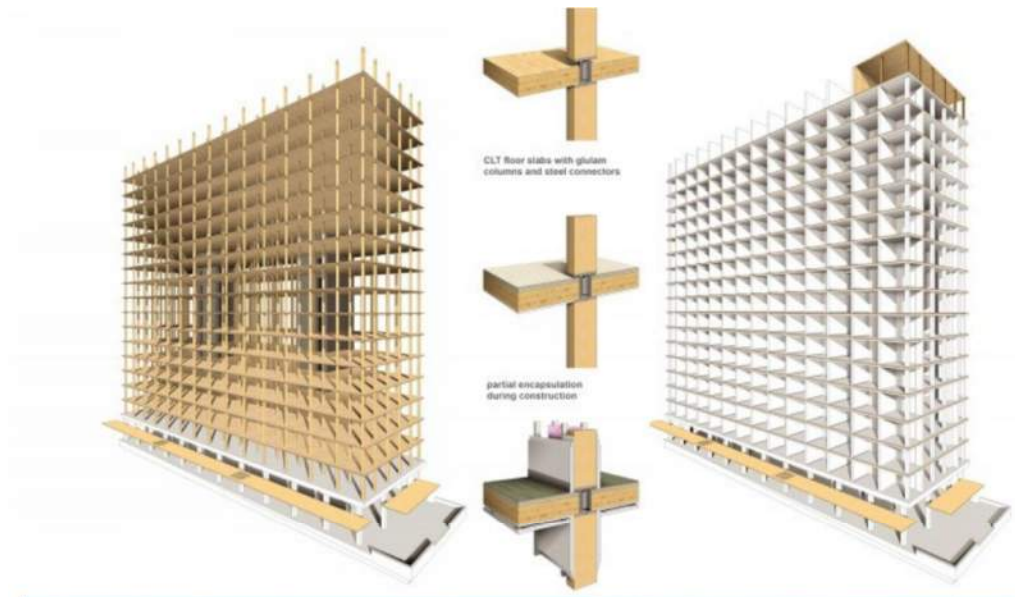
Long Spans



Government Support:

Tackle Climate Change – Use Wood

- Quebec approved mass timber buildings across the province in 2015.
- Oregon: Statewide Alternate Method No. 18-01 passed in August 2018.
- Washington: WA State Building Code Council approved mass timber structures up to 18 stories. New code effective July 1, 2019.
- Federal government continues to fund wood products innovation such as the work of the USDA Forest Products Lab in Madison, Wisconsin.



Round Timber for Columns and Spanning



T-3, Michael Green Architecture and DLR Group |
Minneapolis, MN, USA | 2016

CLT and a Tree

Swap GluLam columns with round timber for:

- Slight increase in diameter
- Lower embodied energy
- Higher carbon sequestration
- Lower price point
- Fast lead times to job site

Combine round timber trusses with CLT decking:

- Thinner depth CLT decking
- Round timber trusses improve deflection
- Sound engineering is still an issue
- Lower embodied energy
- Higher carbon sequestration



T-3, Michael Green Architecture and DLR Group
Minneapolis, MN, USA | 2016

Architects have four common structural materials to choose from:

1. Steel
2. Concrete
3. Engineered Wood
4. Milled Timber and Lumber



Round Timber Structures:

- Use “cull trees,” small diameter trees, restorative thinning, and those with too much character removed from sustainably managed forest lands.
- Employ natural branching and curved aspects of trees to provide axial and lateral bracing.
- Utilize wood’s tensile strength and steel connections for compression and shear.
- Offer a variability curve similar to steel, and far more predictable than milled wood.



Forest Thinnings:

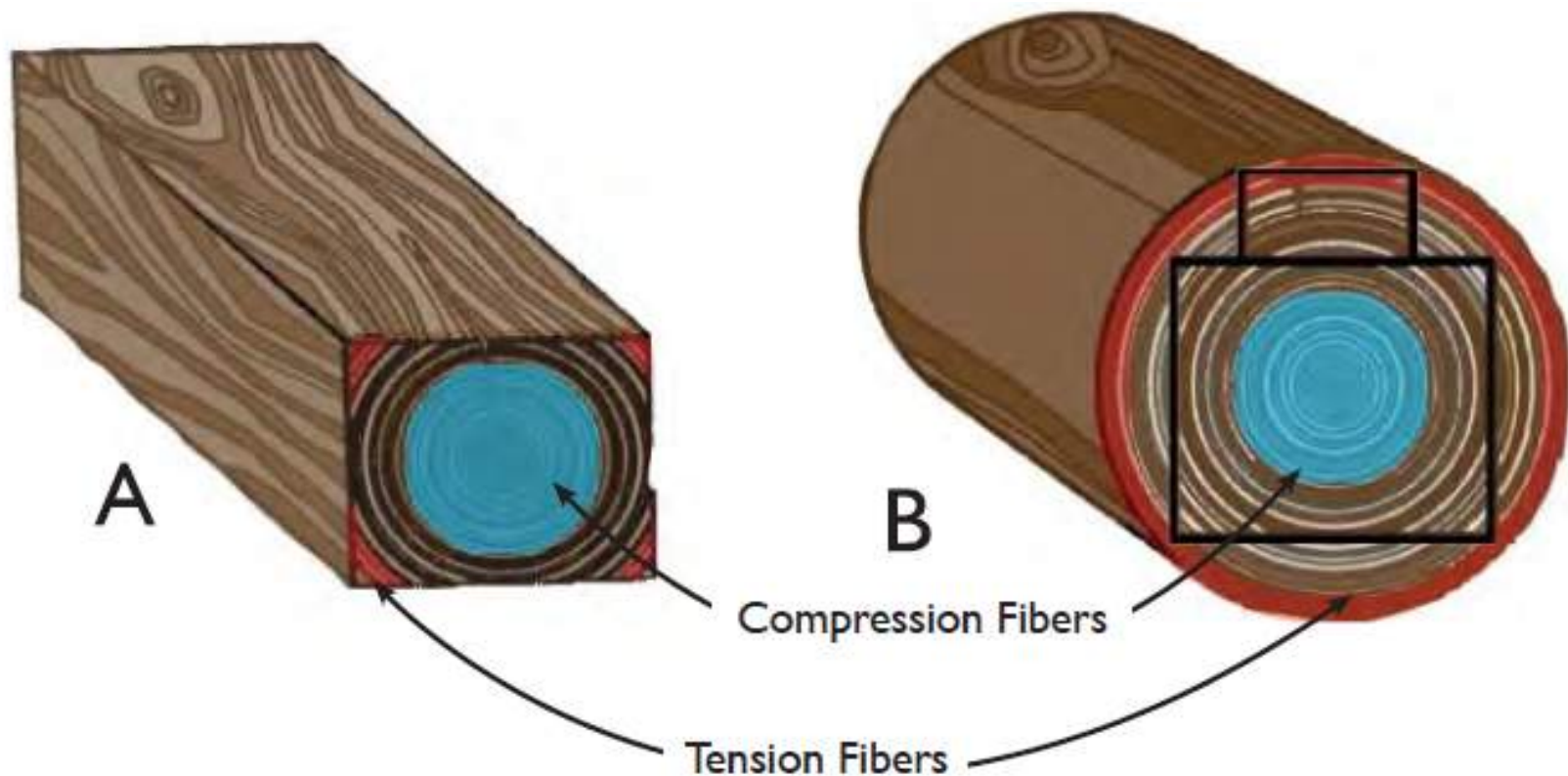
Forest Thinnings, trees marked for removal from healthy forest management, make use of an abundant resource that is replenished in 20-30 years as opposed to 40-60 years for conventionally harvested timber.

When construction markets create demand for younger trees:

- Forest economies improve.
- Forests are better managed.
- Rural jobs are created.
- Resulting forests are healthier and increase their carbon uptake.



Trees are Stronger than Wood



The largest timber (A) that can be milled from any given log (B) will be only 17-33% of the strength of the log.

Trees are Stronger than Wood

Round timber structures use smaller trees, an optimal use of a renewable resource.



80-year-old timber from old-growth trees at least 22" in diameter.
A 14" diameter round timber could be used in this application, representing a 30-40-year-old tree.

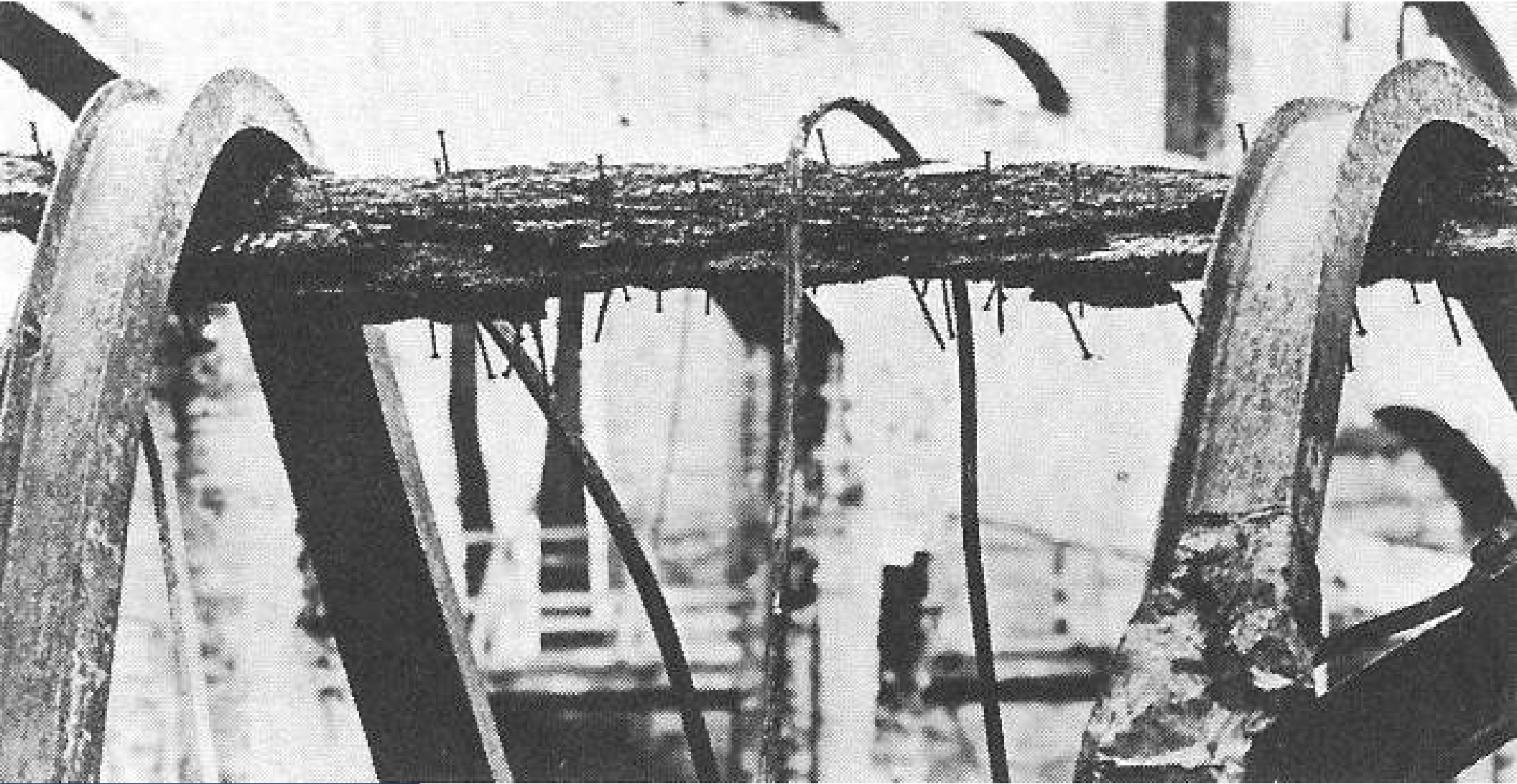
Building Codes

Round timbers fall under building codes Type III-V (Type II with variance)

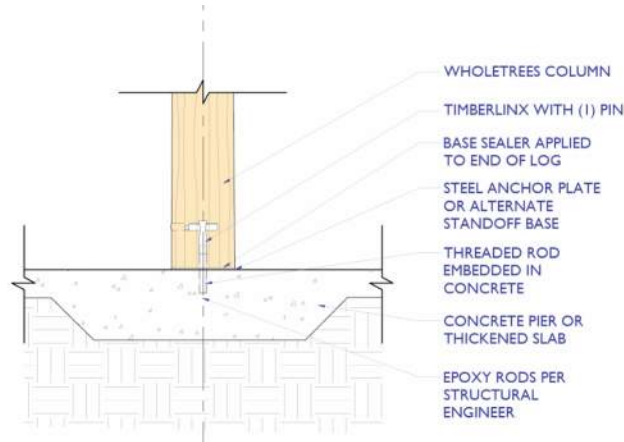


Fire Rating

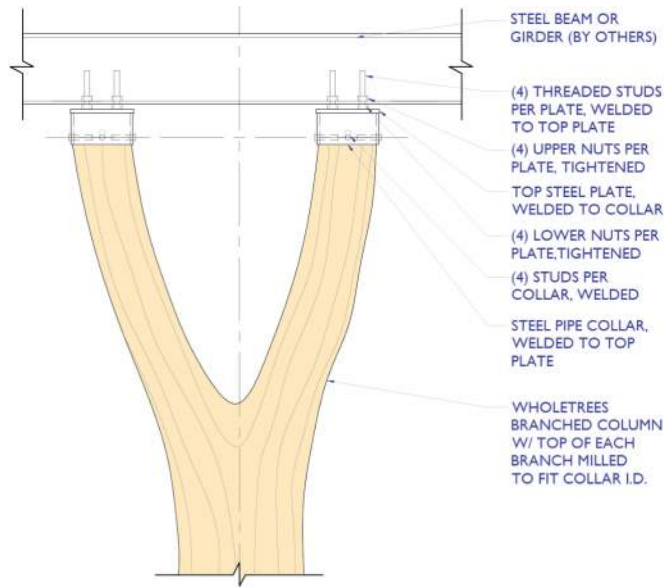
Heavy timbers char instead of melting, and can outperform steel in failure mode



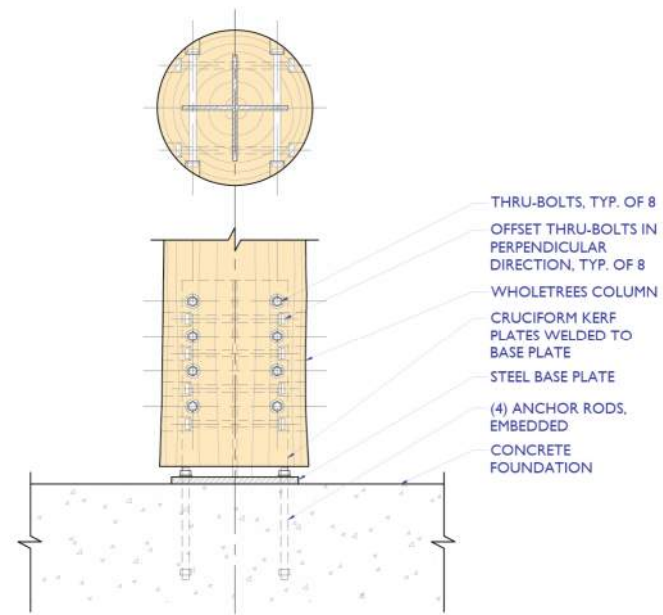
Round Timber Connection Catalog



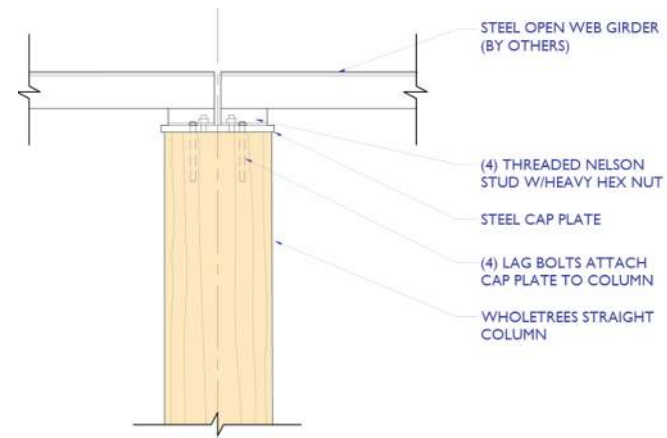
S10 Single Base Anchor to Foundation
SCALE: 1" = 1' © WholeTrees LLC 2017



S33 Branched Column to Steel Beam
SCALE: 1" = 1' © WholeTrees LLC 2017

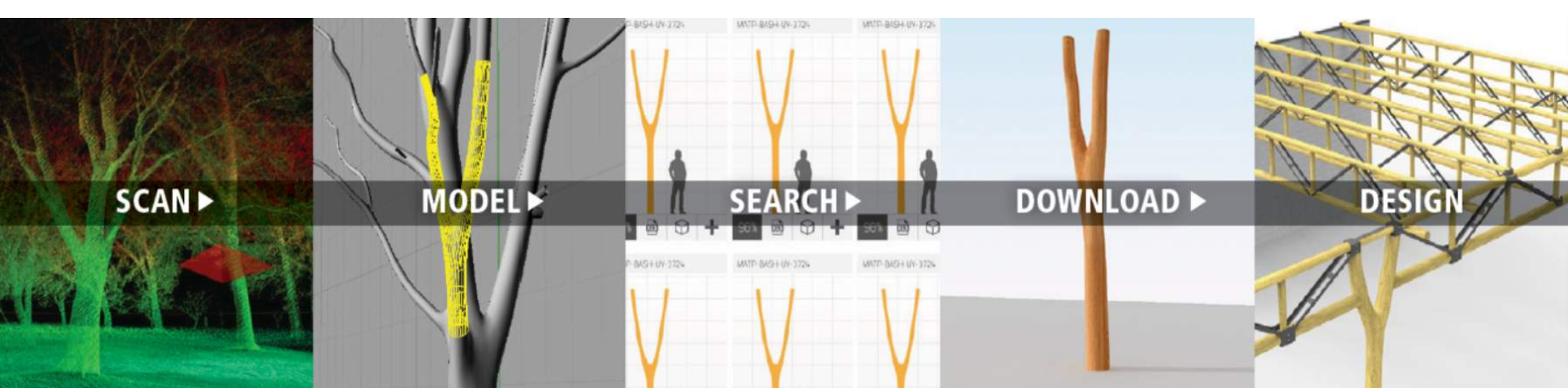


S16 Cruciform Base Plate
SCALE: 1" = 1' © WholeTrees LLC 2017



S22 Pole Column to Steel Girder
SCALE: 1" = 1' © WholeTrees LLC 2017





Research and Development

New Round Timber Products | Advanced Grading Procedures | Inventory and Sales Software Platform

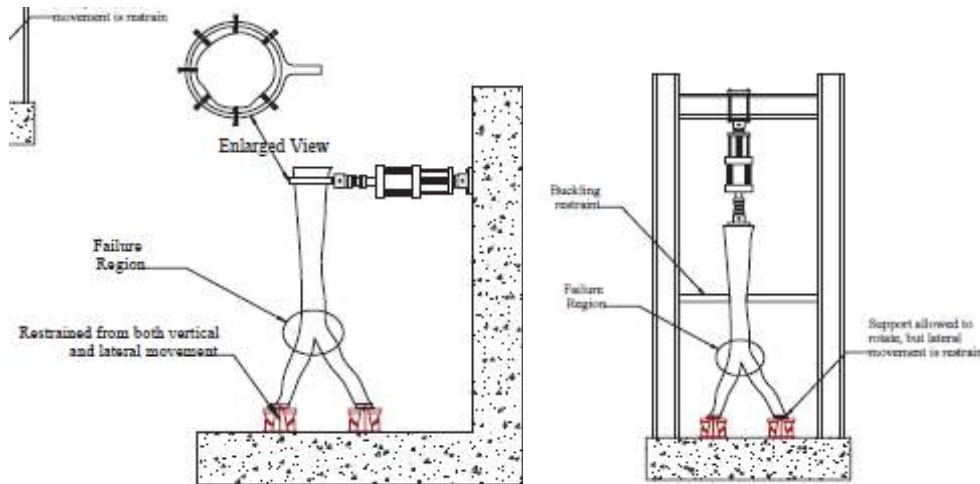


R&D: New Round Timber Products

Non-destructive and failure testing

Quantify shape-determined structural performance

Supply 3D inventory models for BIM and CAD workflows





R&D: New Round Timber Products





R&D: Advanced Grading Technologies

Avg. MOE (psi) of Red Pine Logs		
Top 10%	Top 25%	Top 50%
1,920,000	1,790,000	1,600,000

Table 2: ASTM D198 Bending Test Results Summary

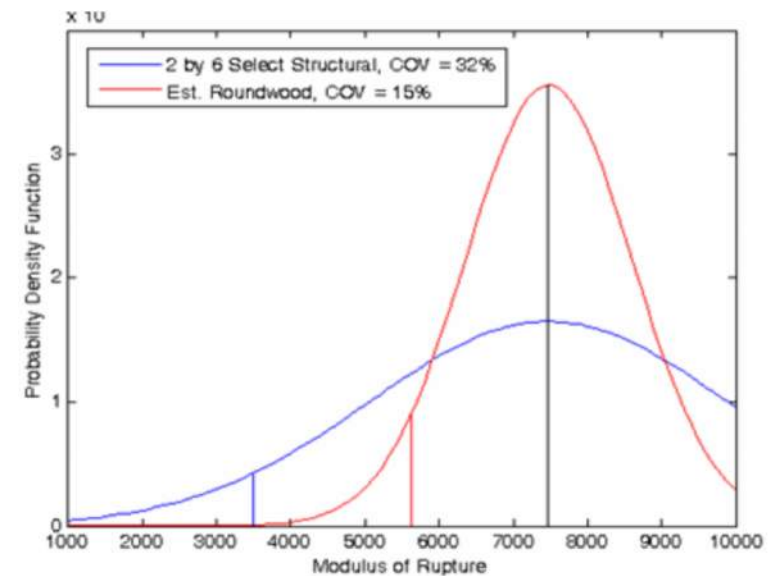


Figure 1: Estimated effects on SDRT design values if variability can be lowered through a reliable MG process developed in this proposed project.

R&D: Advanced Grading Technologies



R&D: Inventory and Sales Platform Software

About the WholeTrees Inventory Platform for Building Professionals:

Searchable database of actual tree specimens with 3D models and material data

3D model library containing standard structural components and assemblies

Catalog of common WholeTrees connection details

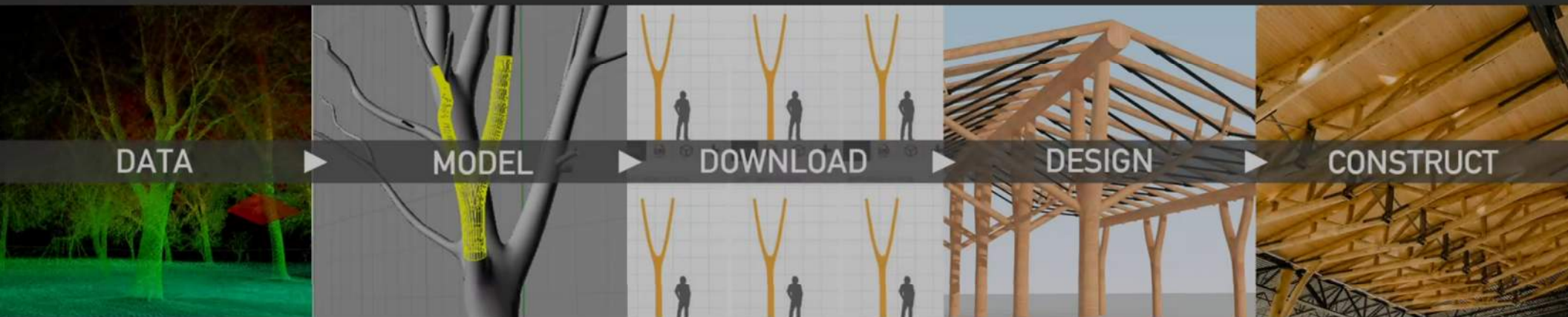


R&D: Inventory and Sales Platform Software



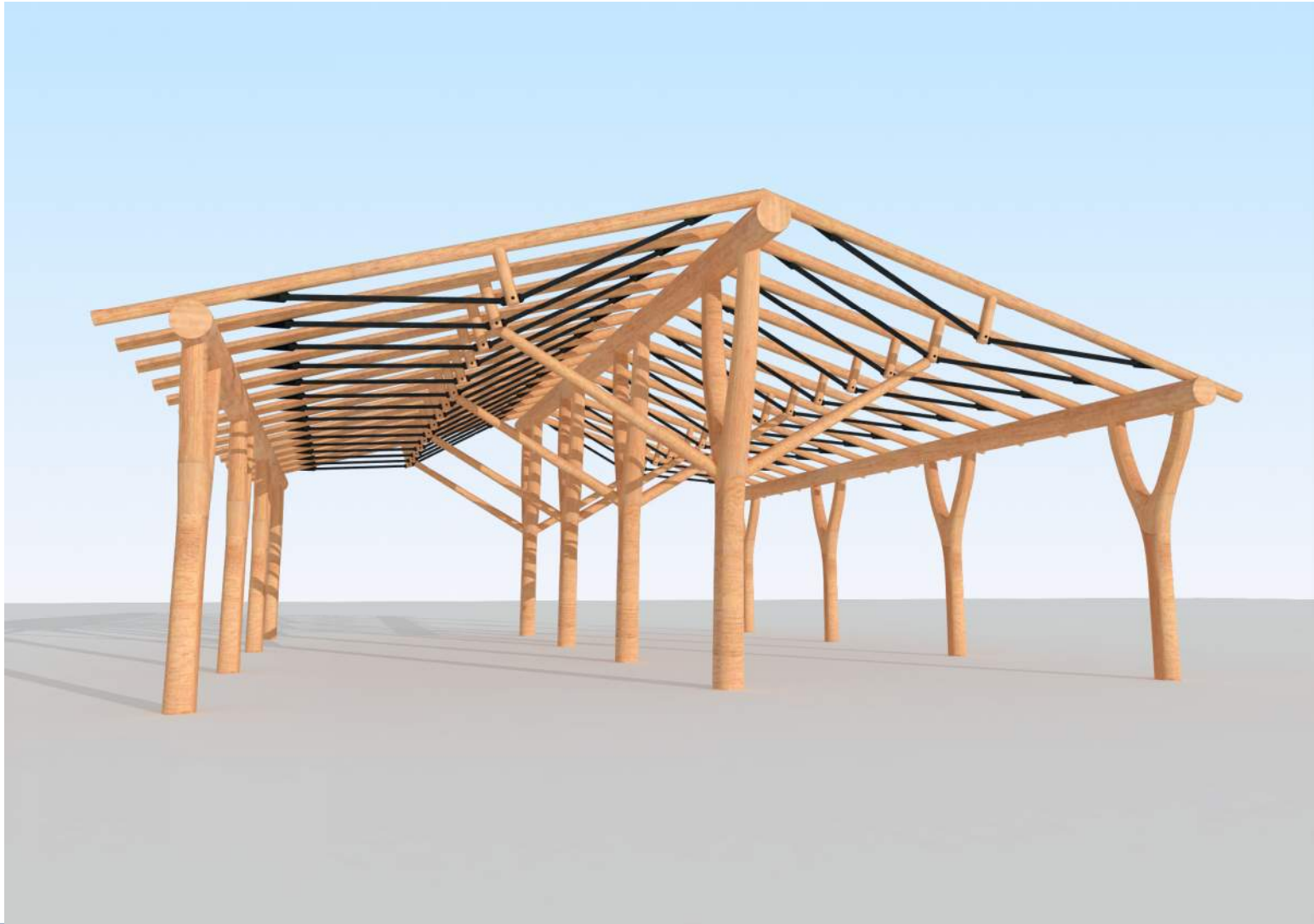
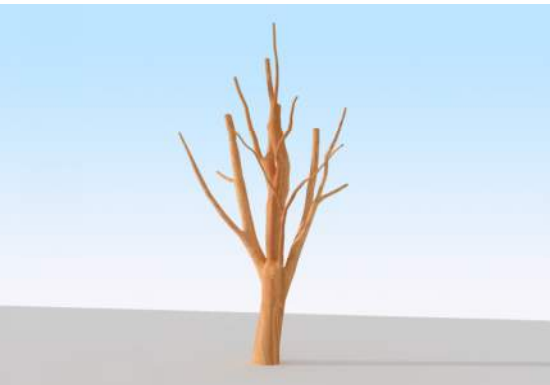
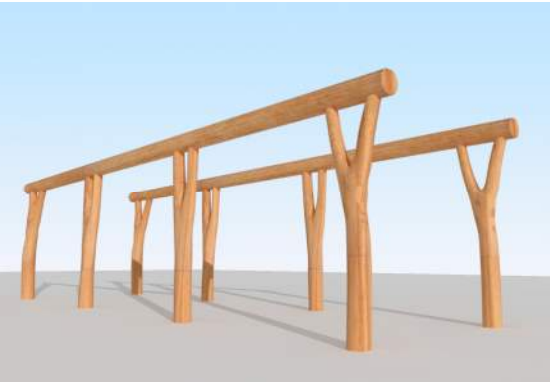
WHOLETREES INVENTORY PLATFORM
WALKTHROUGH

BETA



3D Object Catalog

Explore 30+ downloadable 3D Object files



CAD blocks/3D models for integration into projects

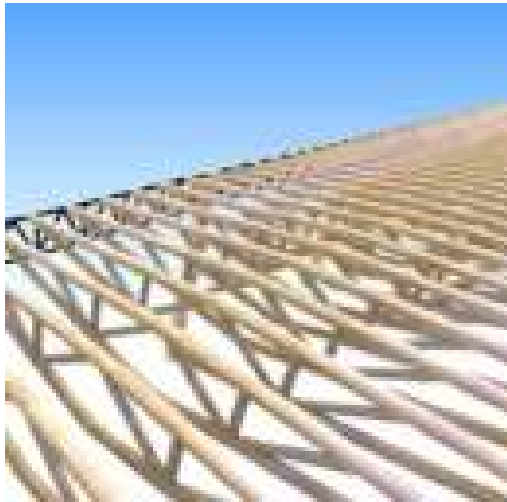
S T R U C T U R E S

Round Timber Products



Beams and Columns

Columns from 8'-30' tall
Beams spanning 12'-30'



Pre-Engineered Trusses

Parallel Chord and Wing
Trusses spanning 20'-60'
Engineering data and load
tables available upon
request



Custom Engineered Assemblies

Bandshells
Event Canopies and
Shade Structures
Solar Panel Carports



Decorative Trees

Non-structural “beauty
trees” from 8'-30' tall

All products come with PE-stamped shop drawings and subassembly packages for code submittal, connection details, and installation manuals.

Competitive Comparison

WholeTrees[®] products and their replacements

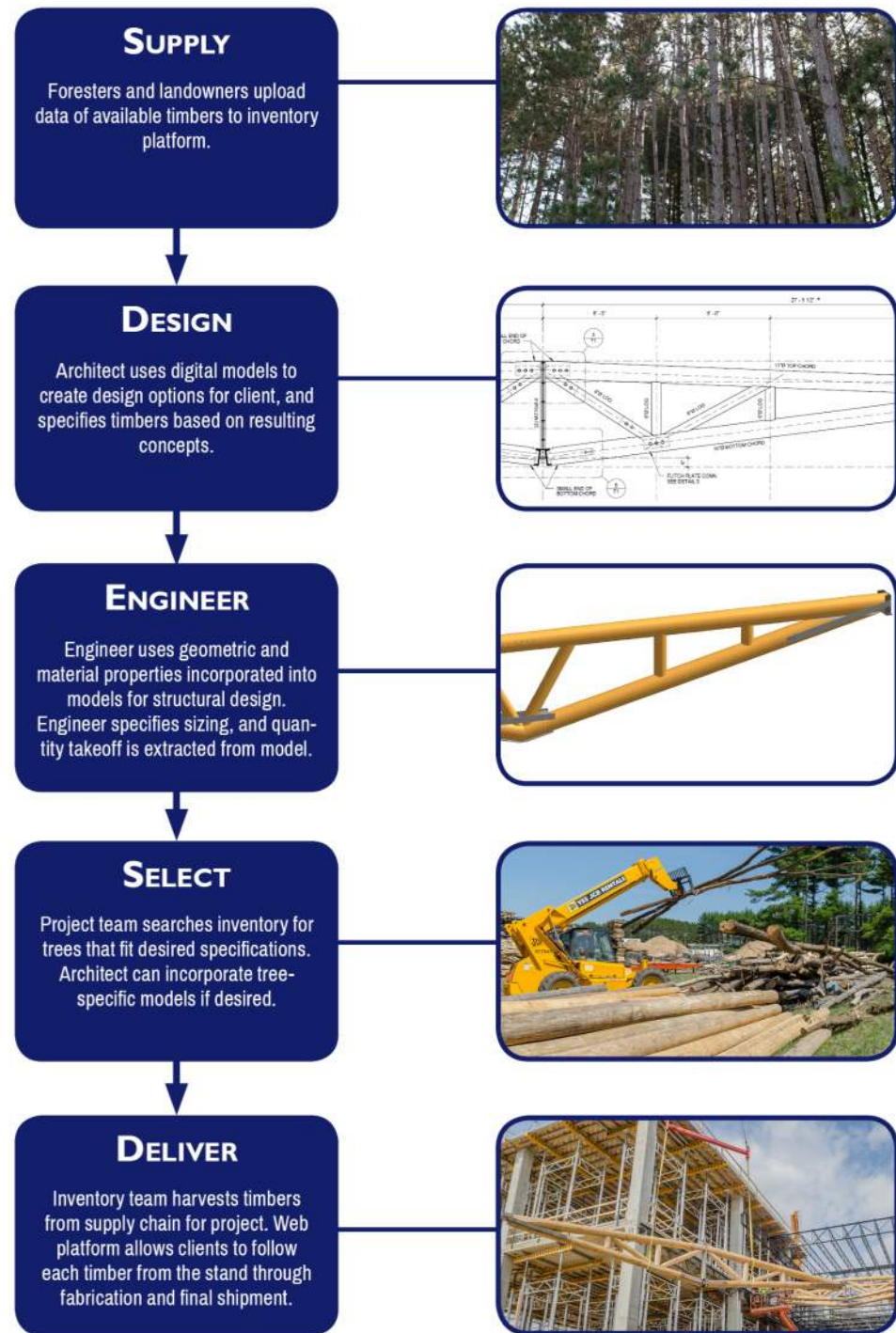
U.S. Structural Products	Price Structure (low/med/high)	Carbon-sequestering	1-3 hour Fire Rating	Regional Sourcing Available for Raw Materials	Industry Examples
Mixed-species round timber structural systems	Med/High	Yes	Yes	Yes	WholeTrees
Pre-engineered mass timber systems (glulam, LVL, CLT's)	Med/High	Yes	Yes	Yes	Various regional fabricators
Pre-engineered nail plate trusses	Low	Yes	No	Yes	Morton Buildings, Cleary Building Corp.
Pre-engineered lumber I-Joists/open-web trusses	Low	Yes	No	No	RedBuilt, Weyerhaeuser
Heavy-gauge steel structures	Low/Med	No	Yes	No	Various regional fabricators

WholeTrees products can compete favorably with long-spanning and heavily loaded glue-laminated timber; heavy-gauge steel applications; and projects where theming, fireproofing, or other coatings are required for alternative products.

Specification Process

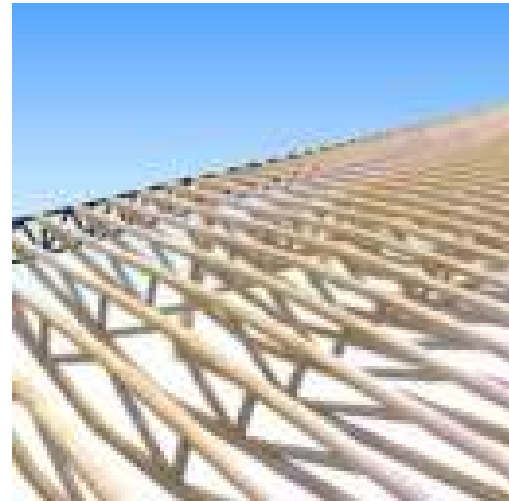
Building professionals can engage WholeTrees at different stages in the design and construction process.

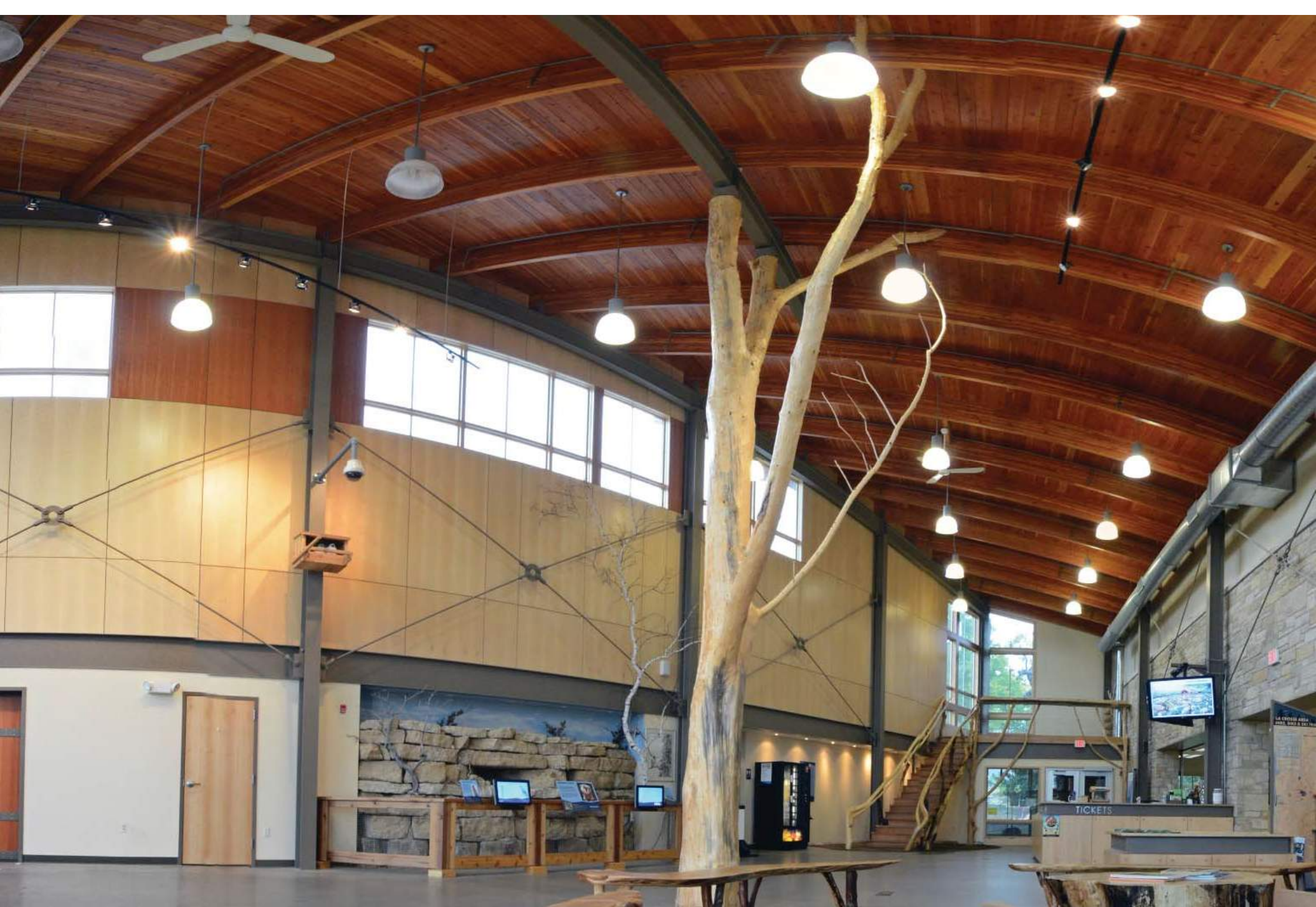
- Supply
- Design
- Engineer
- Select
- Deliver



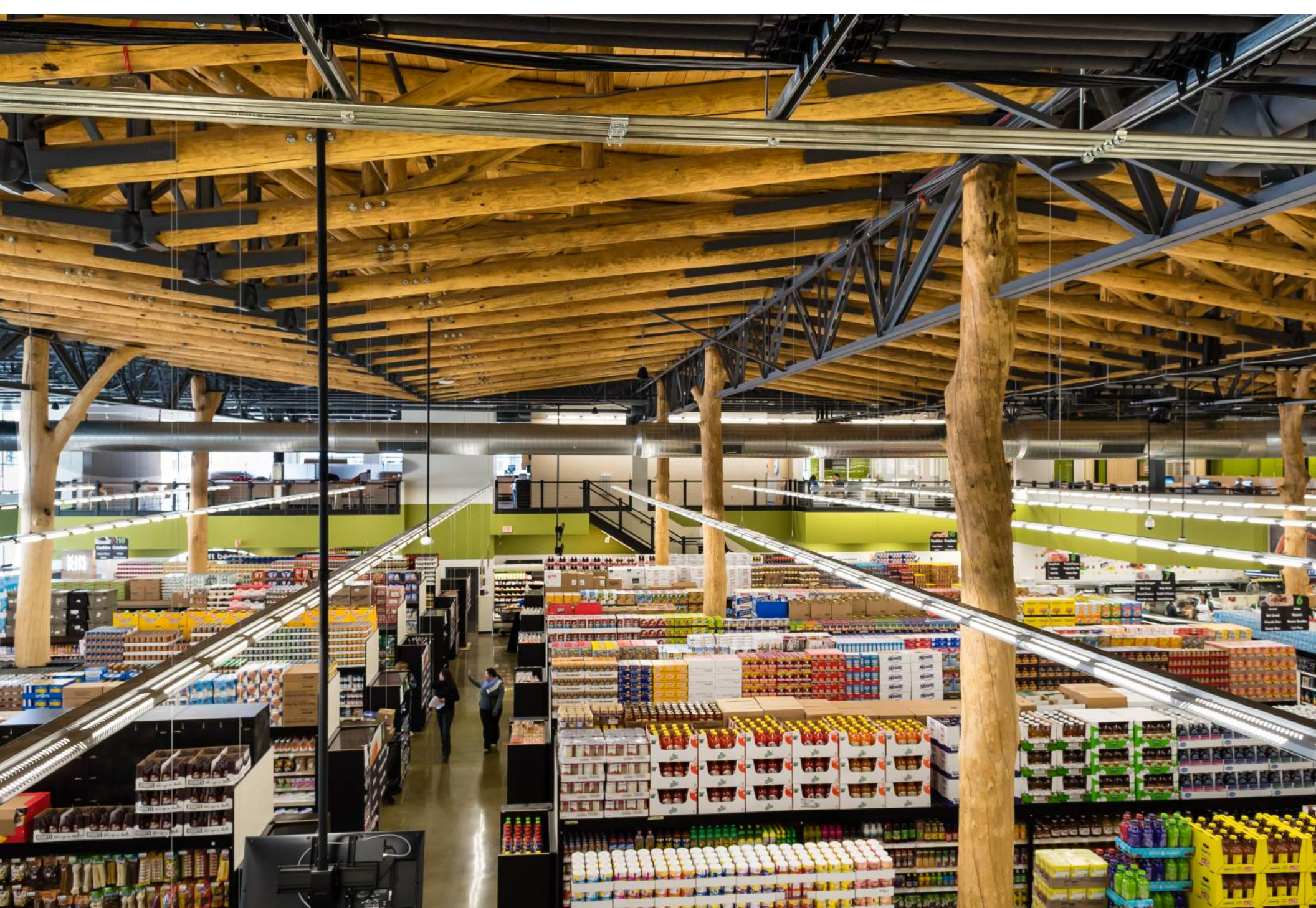
Selected Portfolio

Beams, Columns, and Trusses





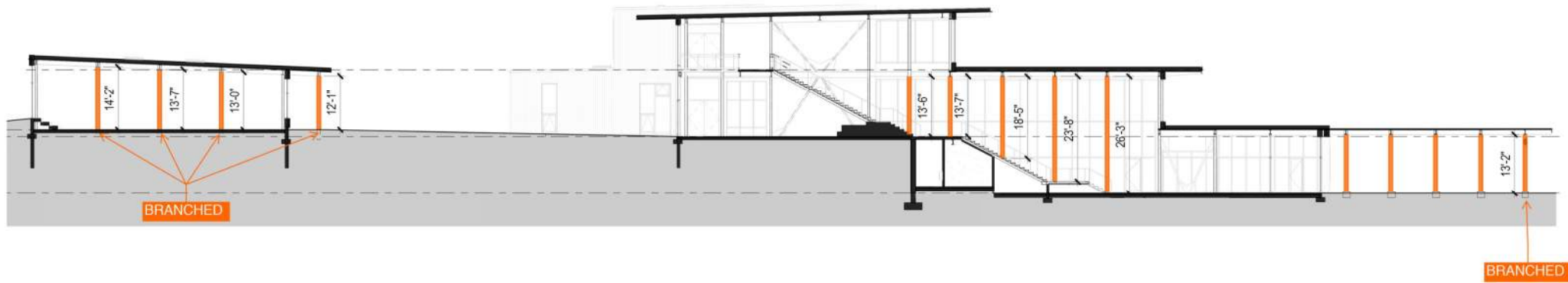


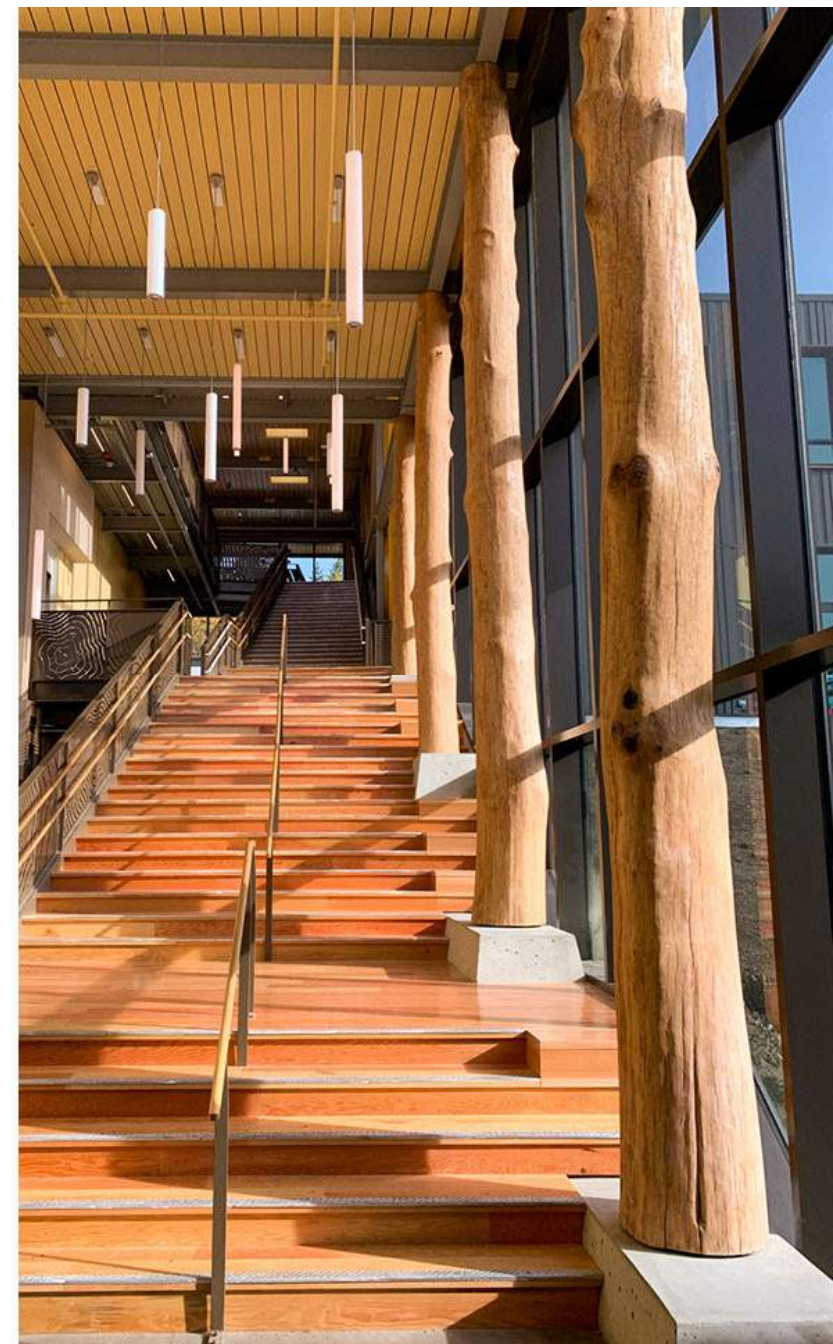
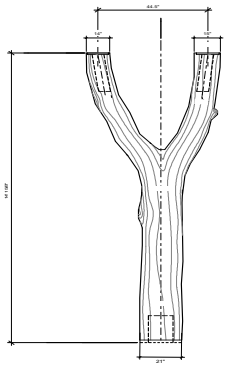


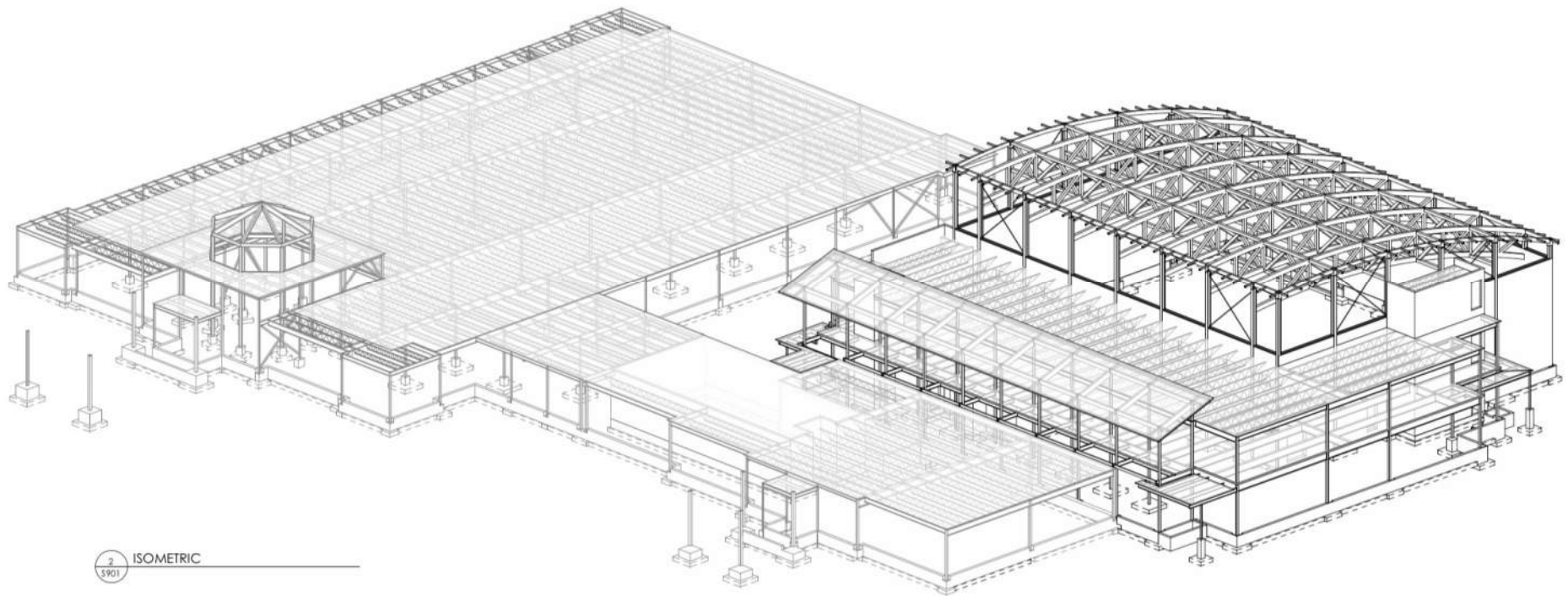
Case Study: Festival Foods Madison

- 560,000 lbs of trees used in the project
- 12 Madison ash columns up to 27' tall
- Engineered details for both straight and branched columns
- 86 round timber trusses
- 55' maximum span by trusses
- 29,000 lbs of load carried by the largest trusses
- 200,000 lbs of total service load supported by structural system
- 1 patented truss design, winner of a 2017 ARCHITECT Magazine R&D Award







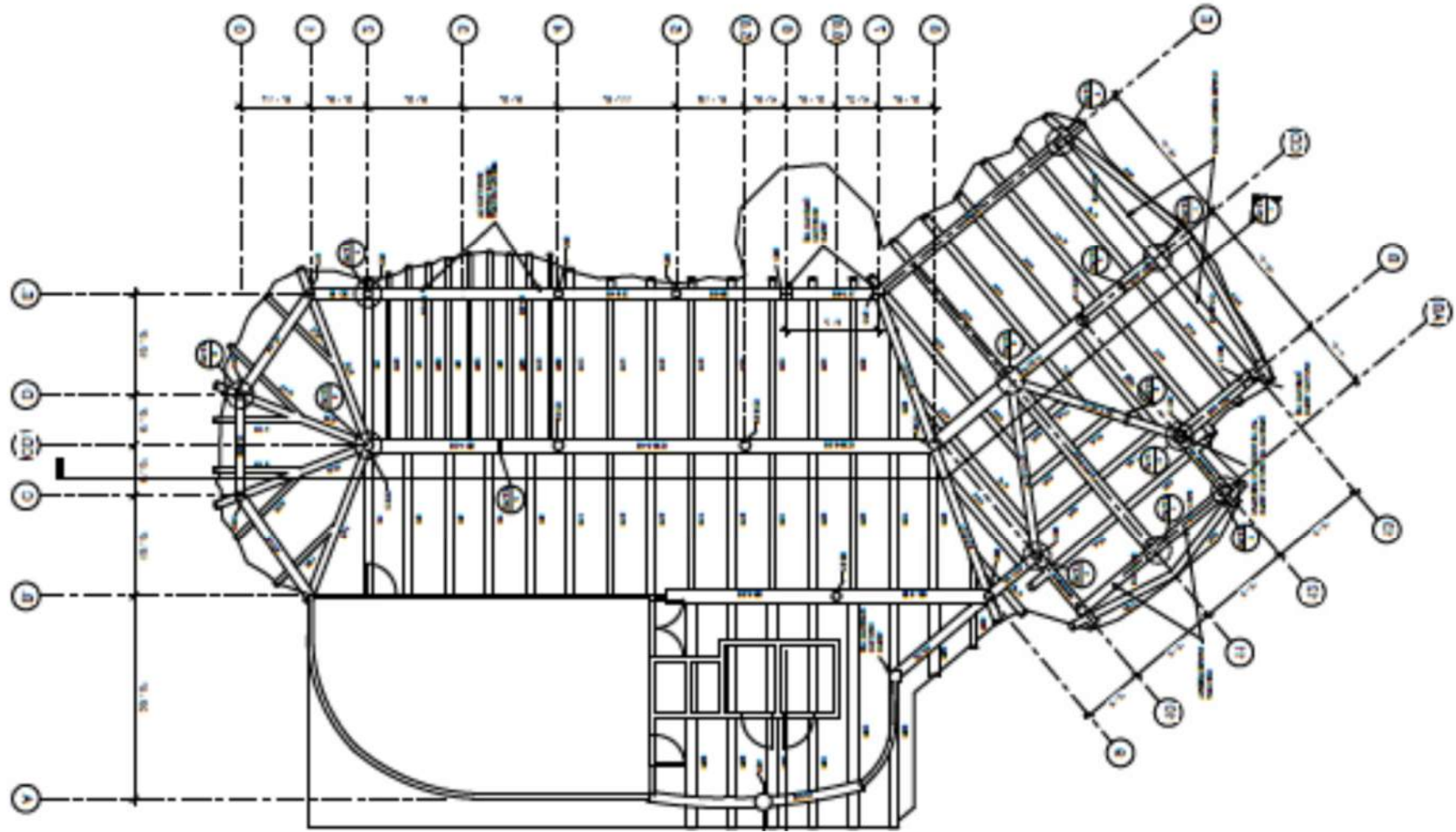
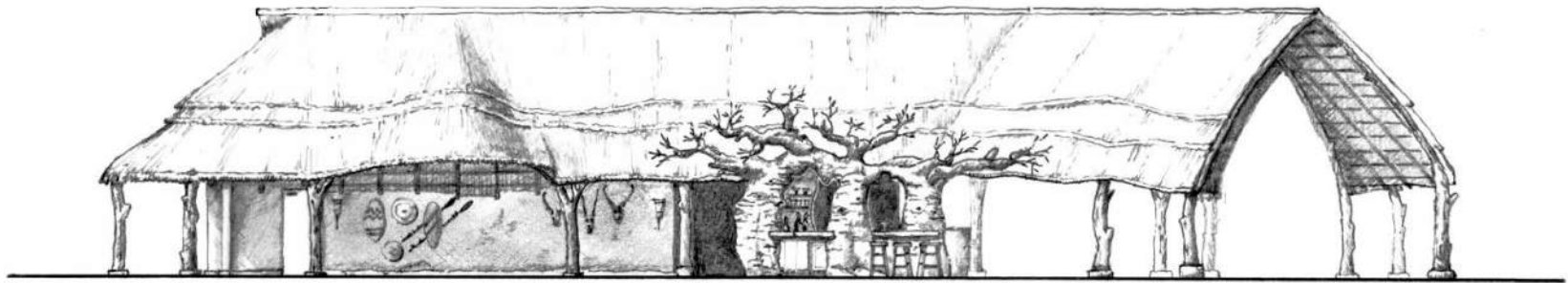


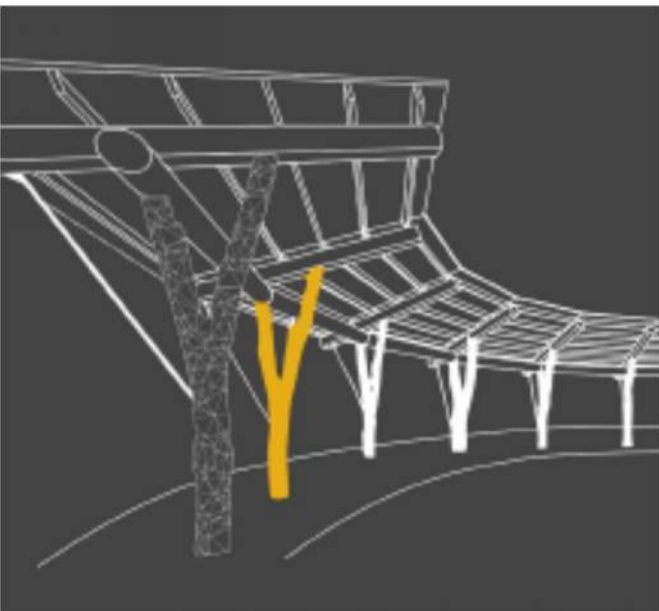
Selected Portfolio

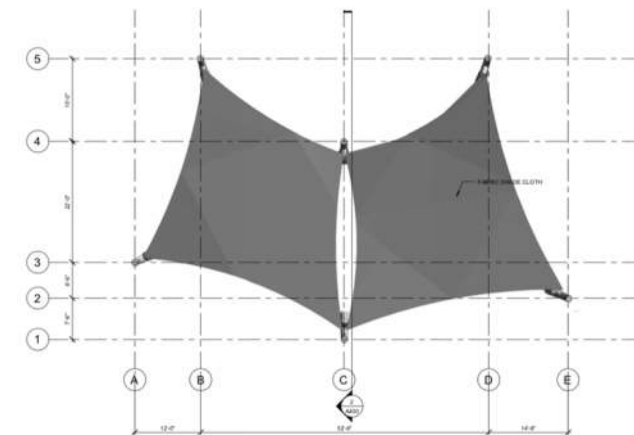
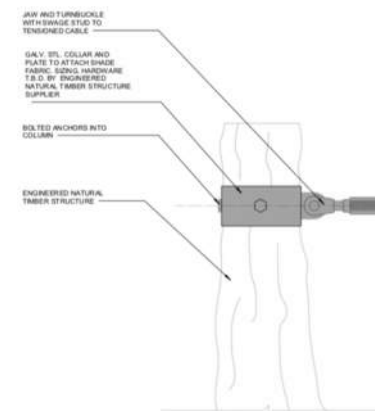
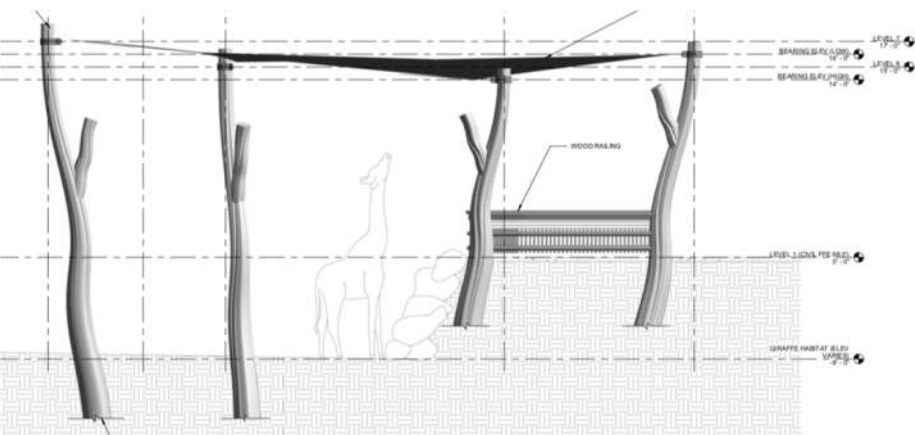
Custom Engineered Assemblies

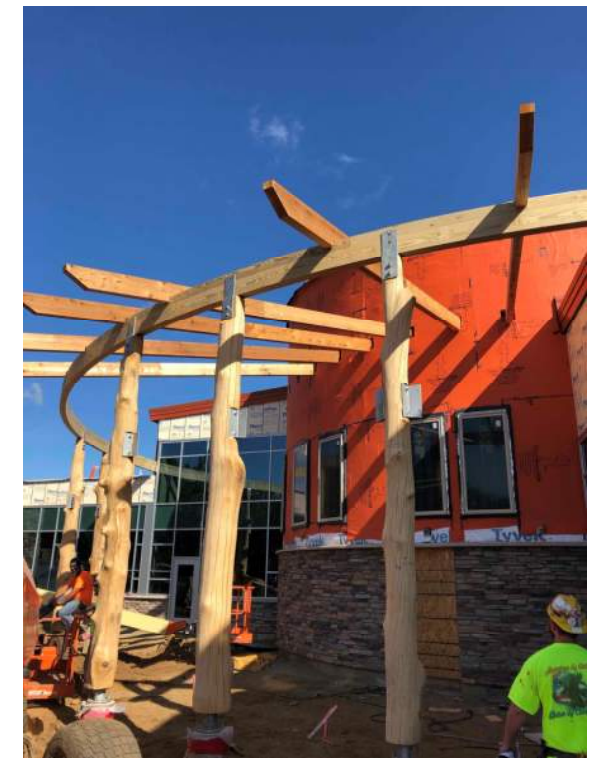


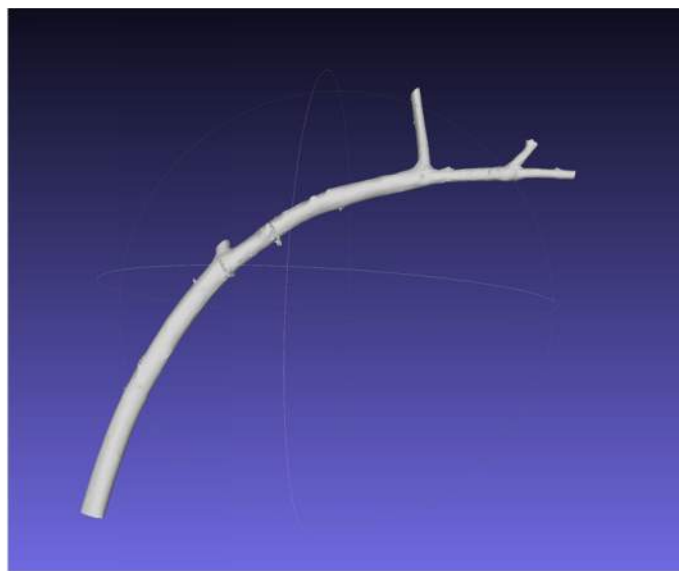




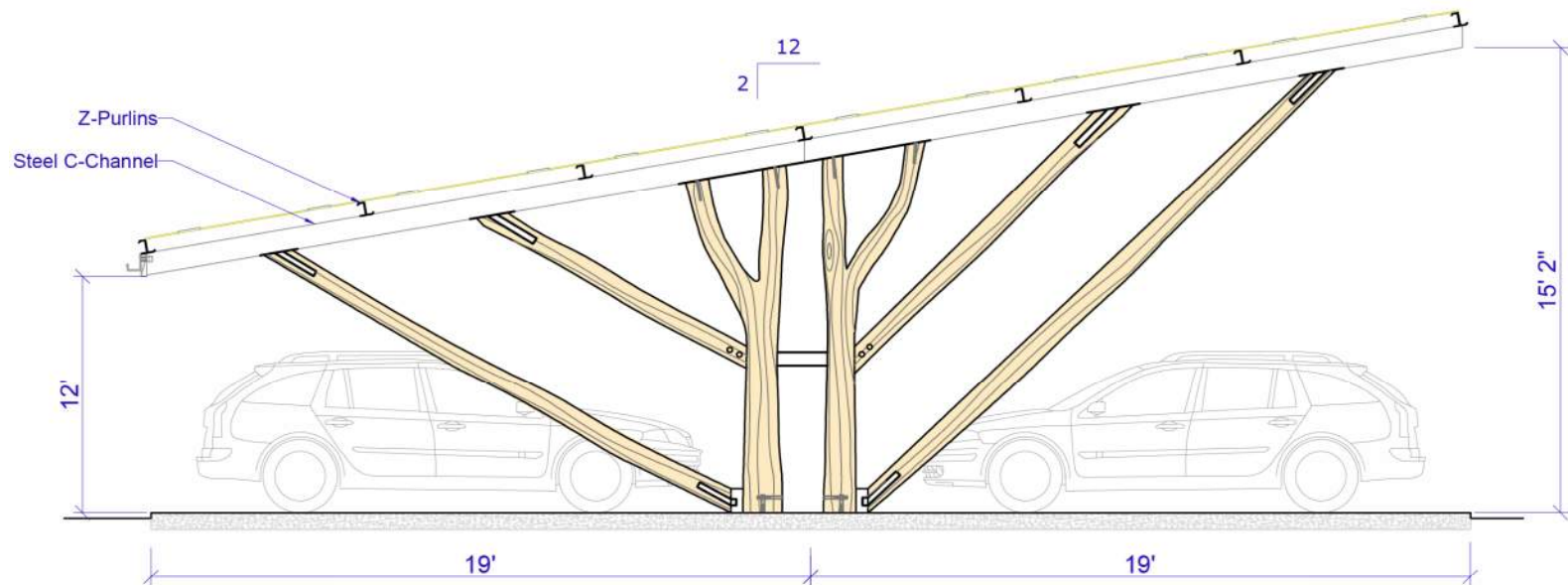












3-Car Bay Cantilevered Solar Carport Elevation

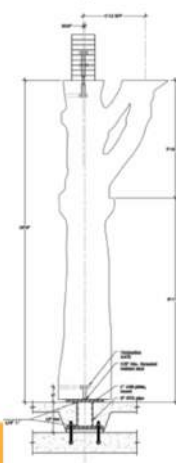


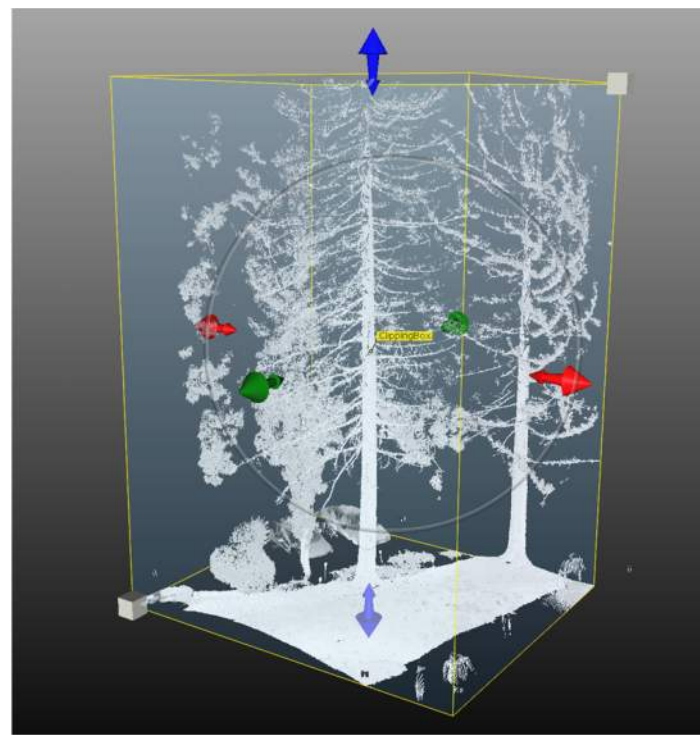


Regional Sourcing Case Study: Lakeridge Junior High



Branching Column: 2793





Regional Sourcing Case Study: Confidential Tech Company



Additional Resources

USDA Forest Products Lab
American Wood Council
Canadian Wood Council
Wood Works
WholeTrees Architecture and Structures

www.fpl.fs.fed.us

www.awc.org

www.cwc.ca

www.woodworks.org

www.wholetrees.com



This concludes the American Institute of Architects
Continuing Education System Course



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