

2017

# Wood Studio Workshop

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UMass STEM Ed Science and Engineering Saturday Seminars

# Wood Studio Workshop


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Photo credit: A. Schreyer



Thompson Community Center, Richmond, British Columbia  
Photo courtesy: Henriquez Partners Architects

# 21<sup>st</sup> century timber engineering

“eco-friendly”

“revolutionary”

“bold and beautiful”

“high-tech”

“new”



Prince George Airport, British Columbia  
Photo credit: McFarlane Green Biggar (MBG) Architects

**17 TALL WOOD BUILDINGS**  
(7 STORIES OR TALLER)  
**HAVE BEEN BUILT IN THE PAST 5 YEARS AND COUNTING**

 <b>TREE</b> Bergen, Norway 12 Stories 2015	 <b>Trafalgar Place</b> London, UK 10 Stories 2016
 <b>Fort</b> Melbourne, Australia 10 Stories 2012	 <b>Banyan Wharf</b> London, UK 10 Stories 2016
 <b>Cenni di Cambiamento</b> Milan, Italy 9 Stories 2013	 <b>Strandparken</b> Stockholm, Sweden 8 Stories 2014
 <b>Paukkuikka</b> Jyväskylä, Finland 8 Stories 2015	 <b>Wood Innovation Design Centre</b> British Columbia, Canada 8 Stories 2014
 <b>St. Die-des-Vosges</b> St. Die-des-Vosges, France 8 Stories 2014	 <b>Pentagon II</b> Oslo, Norway 8 Stories 2013
 <b>Holz8</b> Bad Aibling, Germany 8 Stories 2011	 <b>LifeCycle Tower One</b> Dornbirn, Austria 8 Stories 2012
 <b>Contralaminada</b> Lleida, Spain 8 Stories 2014	 <b>Bridport House</b> London, UK 8 Stories 2010
 <b>Wagnerstrasse</b> Vienna, Austria 7 Stories 2013	 <b>Panorama Giustinelli</b> Trieste, Italy 7 Stories 2013
 <b>Maisons de l'Inde</b> Paris, France 7 Stories 2013	

**42 stories proposed!**

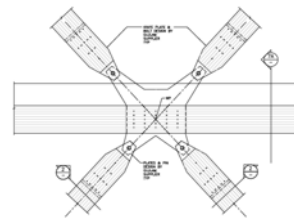
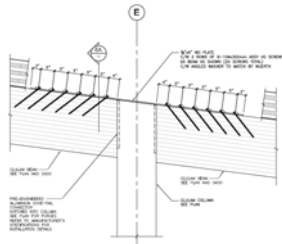
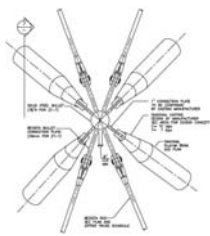
TIMBER TOWER PROJECT  
by SOM

See: [http://www.som.com/ideas/videos/rethinking\\_tall\\_building\\_design\\_the\\_timber\\_tower\\_research\\_project](http://www.som.com/ideas/videos/rethinking_tall_building_design_the_timber_tower_research_project)



## Go UMass!

The Design Building is the most technologically advanced CLT structure in the US



## Primary drivers

Sustainability ←  
&  
Innovation

## Building: one of the biggest culprits of climate change



U.S. ENVIRONMENTAL PROTECTION AGENCY

### Green Building

You are here: [EPA Home](#) » [Green Building](#) » Why Build Green?

Green Building Home

Basic Information

Why Build Green?

Components of Green Building

Building Types

Funding Opportunities

Frequent Questions

Additional Resources

### Why Build Green?

**In the United States, buildings account for:**

39 percent of total energy use  
12 percent of the total water consumption  
68 percent of total electricity consumption  
38 percent of the carbon dioxide emissions

A [list of additional statistics on buildings and the environment \(PDF\)](#) (7 pp, 66K, [About PDF](#)) is available.

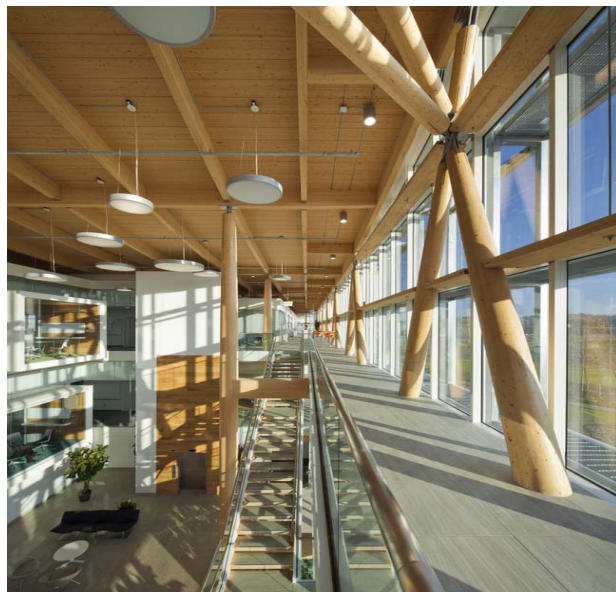
The built environment has a vast impact on the natural environment, human health, and the economy. By adopting green building strategies, we can maximize both economic and environmental performance. Green construction methods can be integrated into buildings at any stage, from design and construction, to renovation and deconstruction. However, the most significant benefits can be obtained if the design and construction team takes an integrated approach from the earliest stages of a building project. Potential benefits of green building can include:



## Green Building Awards



Office Building for GlaxoSmithKline Inc., Quebec Nordic CLT. Photo credit © Stéphane Groleau



“Wood can help to earn points in categories typically found in green building rating systems— including certified wood, recycled/reused/salvaged materials, local sourcing of materials, waste minimization, indoor air quality, advanced building techniques and skills and life cycle impacts” ...

Quote source: RETHINK Wood

## Carbon sequestration and storage



- Wood and wood products store carbon until they burn or biodegrade

## Wood products are carbon negative

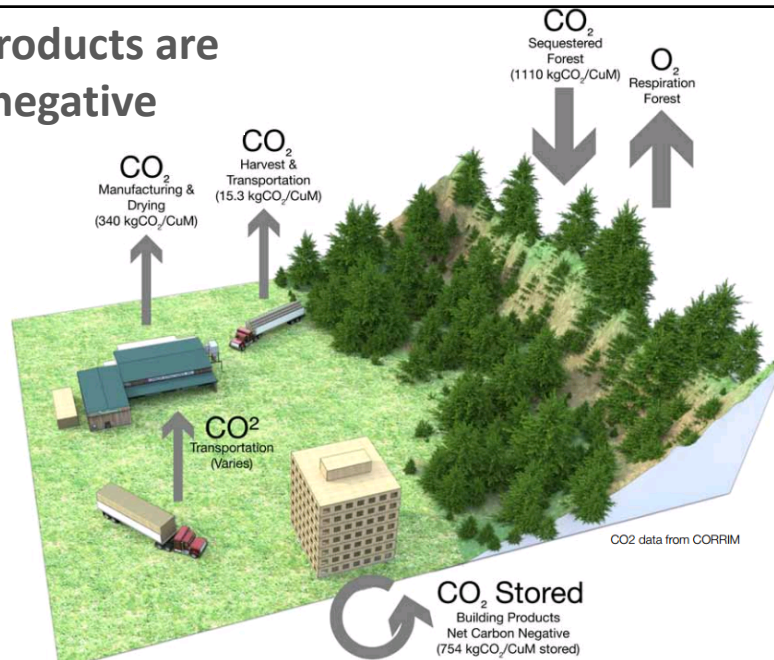


Image courtesy of Joseph Mayo of Mahlum | Architects Inc.



## Life Cycle Assessment (LCA)

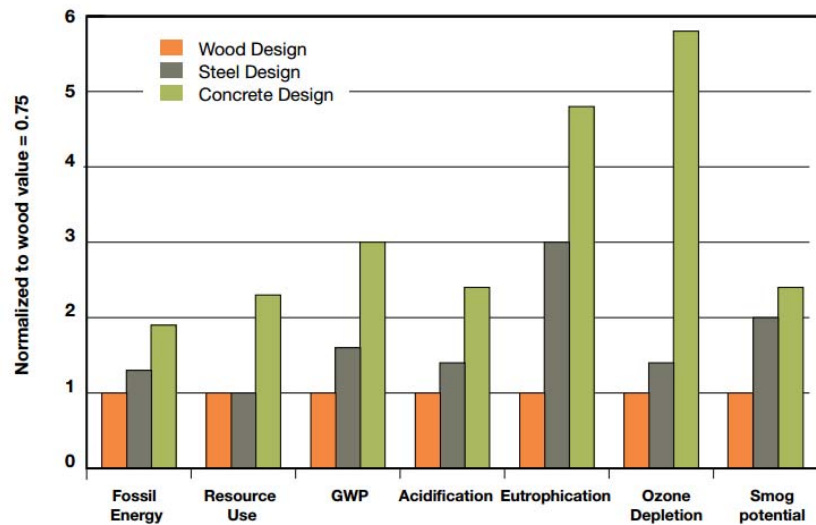


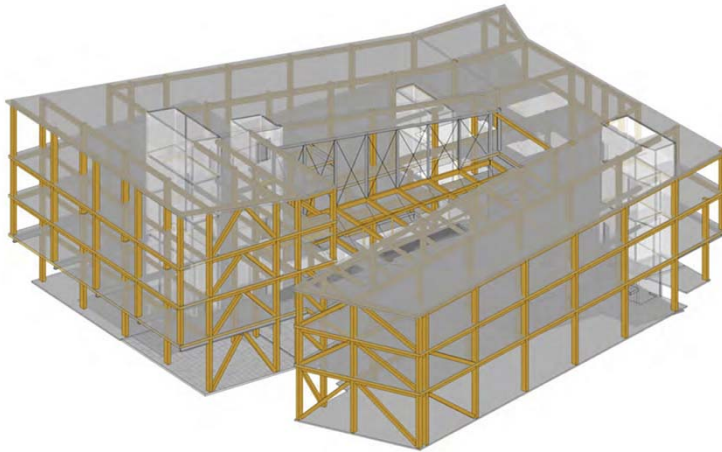
Image source: ReTHINK WOOD® - Building Green with Wood (Module 2)

## Healthy Indoor Environment

- Stress reducing effects  
<http://woodworks.org/wp-content/uploads/Wood-Human-Health11.pdf>
- Humidity control
- Advanced adhesives with minimal to no off-gasing

Image source: Prof. DDI Michael Flach

## UMass Design Building



## Carbon Summary

<b>V</b>	Volume of wood products used (m <sup>3</sup> ): <b>2081 m<sup>3</sup></b> (73482 ft <sup>3</sup> ) of lumber and sheathing
	U.S. and Canadians forests grow this much wood in: <b>6 minutes</b>
<b>C</b>	Carbon stored in the wood: <b>1463 metric tons of CO<sub>2</sub></b>
	Avoided greenhouse gas emissions: <b>1218 metric tons of CO<sub>2</sub></b>
	Total potential carbon benefit: <b>2681 metric tons of CO<sub>2</sub></b>

### Equivalent to:

	<b>512 cars</b> off the road for a year <sup>1</sup>
	Energy to operate a home for <b>228 years</b> <sup>1</sup>

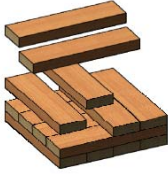
reTHINK  
**WOOD**

## Primary drivers

Sustainability  
&  
Innovation ←



# Mass Timber



Cross Laminated Timber (CLT)



Glulam



Parallel Strand Lumber



Wood Concrete Composites



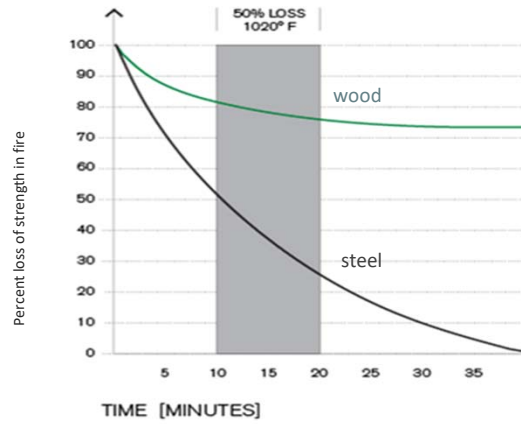
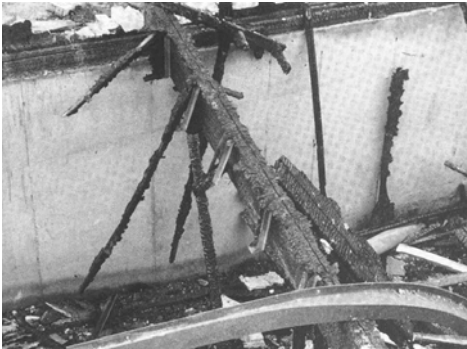
## Fire Safety with Mass Timber



Char protects the inner core



Large trees remain after forest fire



**Let's make some Glulam beams!**

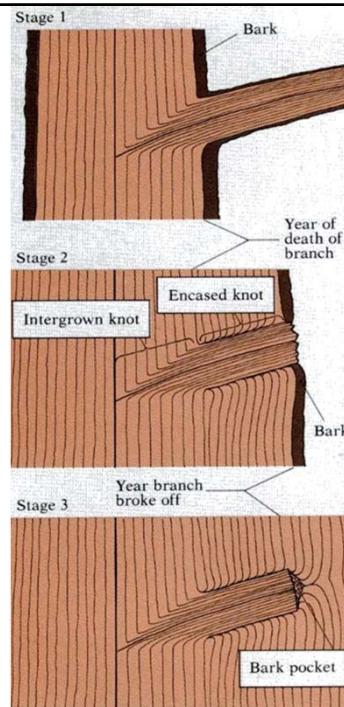
## Why is Glulam strong?

1) Defects are dispersed



Glulam

## Wood knots





## Stress grades



Select Structural



No. 1



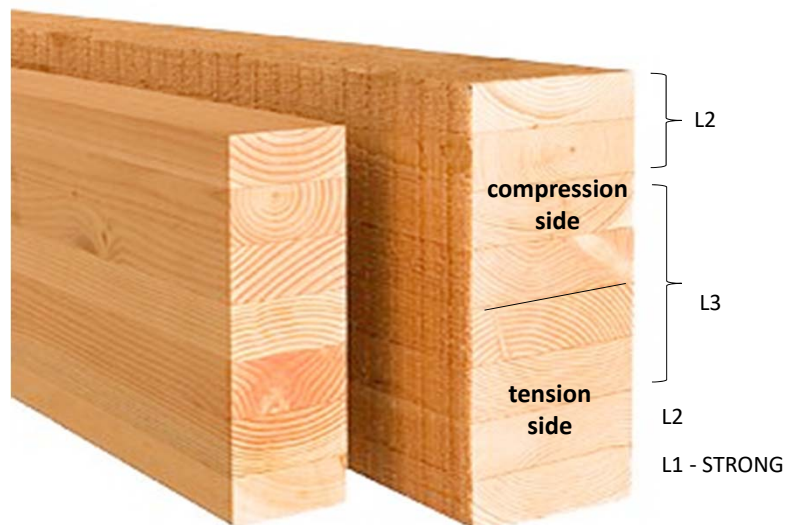
No. 2



No. 3

## Why is Glulam strong?

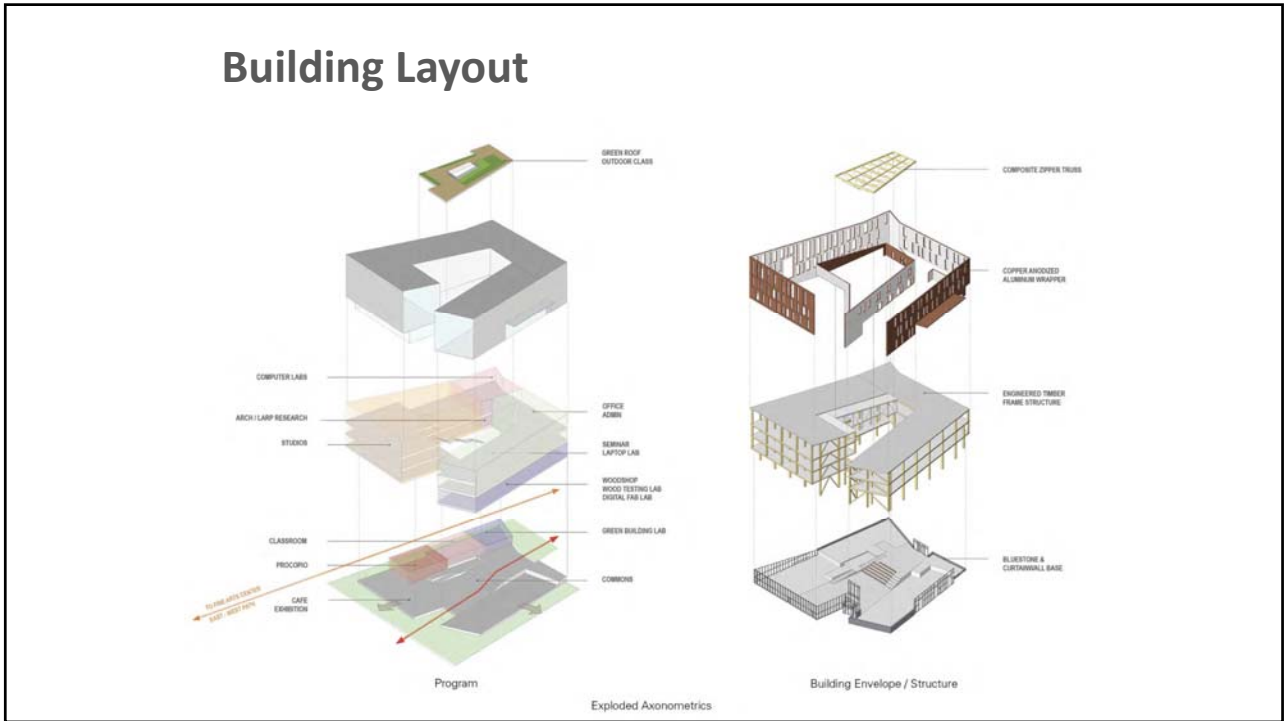
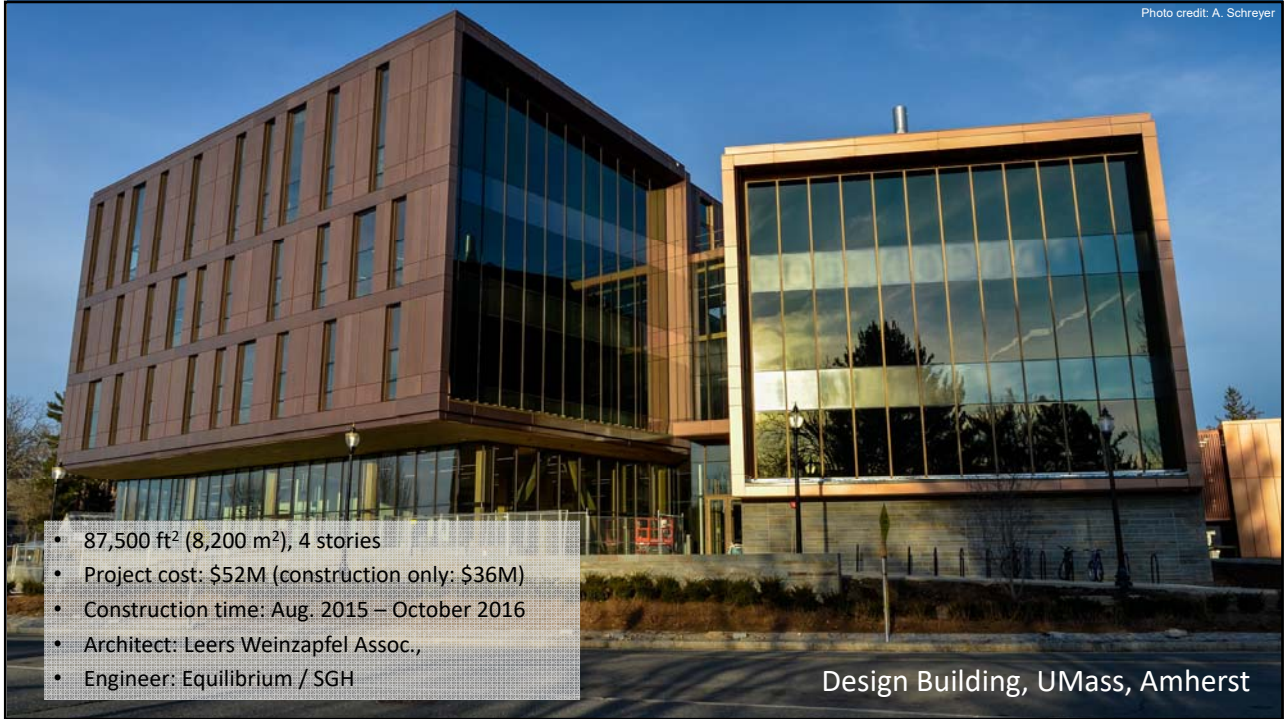
2) Layup is engineered



Different species have different strengths

<b>Wood Species</b>	<b>Bending Strength (kPa)</b>
White Ash	103,000
Black Spruce	74,000
Douglas-Fir	85,000
Eastern Hemlock	61,000

**Design Building Tour**















### FAST glulam column installation





## Design Building in Construction: 1 work day



**The Design Building Floors are Special**





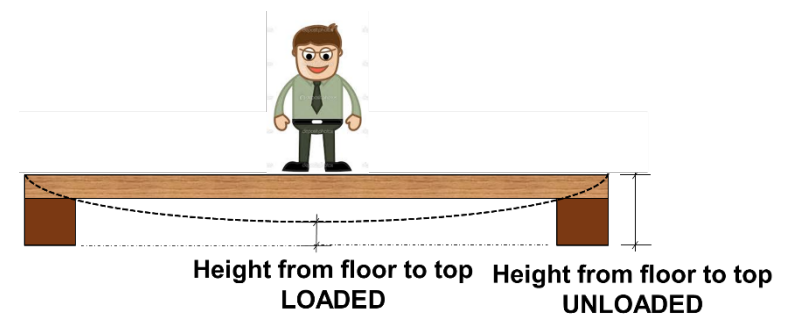




- Why go to all the extra trouble to connect the concrete to the wood?
- Because it's much stronger and stiffer that way
- And it all has to do with **Composite Action**



# Composite Action ... in action!



Case			Measurements		Calculations	
			Height from floor to top UNLOADED (mm)	Height from floor to top LOADED (mm)	Deflection, $\Delta$ (unloaded height - loaded height)	Comparisons
A		One wood plank only				n/a
B		Two wood planks <i>unconnected</i>				$\Delta_A = \text{_____} \times \Delta_B$
C		Two wood planks laid side by side				$\Delta_B = \text{_____} \times \Delta_C$
D		Two wood planks <i>connected</i>				$\Delta_B = \text{_____} \times \Delta_D$
E		Two wood planks with HardiePlank <i>unconnected</i>				$\Delta_D = \text{_____} \times \Delta_E$
F		Two wood planks with HardiePlank <i>connected</i>				$\Delta_E = \text{_____} \times \Delta_F$