Wood construction: The role of research and education in overcoming barriers to growth

Iain Macdonald
TallWood Design Institute, Oregon, USA
1. Who is TallWood Design Institute?
2. Current sector growth and barriers
3. Research activity in North America
4. Education:
   - jobsite skills
   - Supply chain skills
   - Design skills
TallWood Design Institute

An industry-driven partnership between:

• College of Forestry, Oregon State University
• College of Design, University of Oregon
• College of Engineering, Oregon State University
Our Mandate

1. Grow the manufacturing base for structural wood products – especially mass timber - in the US
2. Eliminate barriers and stimulate demand for structural wood products and building systems throughout the US
TallWood Design Institute

- Industry-focused applied research
- Product development and testing
- Training and education
Sources of Opportunity for Wood in Construction

1. Interest in addressing climate change
2. Development/ popularisation of mass timber products and systems
3. Expansion of offsite construction
Global CLT Production
South Africa’s first locally manufactured CLT structure in Cape Town

South Africa’s first producer of CLT begins operations

Jamie Smily of XLAM
Mass Timber Capacity Growth in North America

- Structurecraft DLT plant, BC
- Element5 CLT - Ontario/Quebec
- Freres Lumber Company – opened December 2017
- SmartLam (Montana) – expansion in Montana, new plant in Maine, one more in US South East?
- Katerra (WA) – planning two more CLT plants in next 2 years
- Vaagen Timber (WA) – CLT plant announced for 2018
- International Beams (Alabama)
- Arkansas – conversion of sawmill site to CLT plant
Barriers to Growth?

• **Cost uncertainties** and **lack of familiarity** among designers, engineers, construction industry, permitting authorities

• **Design-related**: seismic and wind resistance, fire safety, durability (moisture), acoustics, lack of standardized connector systems and assemblies

• **Manufacturing**: computer aided design skills, computer numerical control fabrication machinery skills, digital integration from screen to machine and jobsite; aversion to capital investment risk; drying capacity

• **Construction**: different installation skills required than typical general contractors possess, design-bid-build model is not optimal for project efficiencies

• **Building codes**
Addressing barriers through research
USDA Forest Products Laboratory, Nov 2015
Mass Timber Research Workshop

• Seismic response of wood buildings
• Highlighted need for large-scale tests, including "shake and bake"
• Effects of moisture
• Adhesives with lower enviro impact
• Lifecycle analysis
• Vibration and acoustics
• Building performance, monitoring, building physics
• Fire performance
• Preventing fires during construction
• Blast resistance
• Timber/concrete composites
• Fiber supply, using low value species, thinnings
ICC Tall Wood Buildings Proposal

Allows 3 new mass timber building types to be built within code in the United States:
• Type IV-A – Wood buildings up to 20 storeys
• Type IV-B – Wood buildings up to 12 storeys
• Type IV-C – Wood buildings up to 9 storeys
“Mass Timber and Tall Wood Building Research in Canada and the United States”

Sources:

Natural Resources Canada
FPInnovations
Mass Timber Institute
Ontario Ministry of Natural Resources and Forestry
Softwood Lumber Board
TallWood Design Institute
U.S. Forest Service - Forest Products Laboratory
98 research projects underway on mass timber, heavy timber, and mid-rise light-frame construction

Seismic, wind and structural performance (27)
Cost, market and adoption (21)
Durability (16)
Fire performance (12)
Energy, performance and environment (6)
Mechanical properties (5 projects)
Acoustics and vibration (4)
Building physics and health (3)

Education, technical, training support and research needs (6)
Other “Trending” Research Topics

• Modular hybrid buildings utilizing mass timber (military, disaster-relief, affordable housing)
• Non-destructive testing
How to Align Research to Industry Needs?

- Maintain and share a database of projects
- Disseminate research outputs more effectively
- Research symposium to identify research gaps
- Involve industry in review and selection of projects for funding
- Research collaboratives – jointly setting and funding research agenda
- Understand how to adapt European research results to other regions
Addressing barriers through education
Construction skills: where we are today

Skills shortages
caused by layoffs and exodus of workers after Great Recession, Baby Boomer retirements
73% - find it difficult to fill positions
75% - expect this to continue or worsen
50 years – average age of construction tradesperson
157,000 - new employees needed by 2020
Other factors driving industrialized construction growth....

• Increasingly unaffordable housing
• Quality concerns
• Need for greater energy-efficiency
• Attract young workers into sector
• Densification – building in urban infill
Technology trends

• Building Information Modeling
• CNC fabrication
• Robotics
• Wood products innovations
Jobsite skills
Mass timber: what’s different on the jobsite?

- Less people
- Shorter construction times
- Less hot work and wet trades
- Reduced waste and clutter
- Reduced deliveries
- Less noise
- Less change orders and rework
What’s different on the jobsite?

- Tighter tolerances
- Greater need for efficient, pre-planned logistics (offloading, crane use, assembly sequence)
- CAD models can generate construction sequencing
- Need to closely coordinate with designers and other trades earlier in the process
Construction companies on the learning curve
The 21st century master builder?

“To become a Master Builder an architect must not only be possessed of the theoretical knowledge of engineering and a knowledge of the details of building construction, but he must become the devisor of methods of construction”

Proceedings of the Annual Convention of the American Institute of Architects, 1926
Supply chain skills
Commodity → Custom
Over 80% of world production is used in structures allowed in current codes.
No Dominant Supply Chain Model
Manufacturers need new skills

- 3D CAD
- BIM
- CAM and CNC Manufacturing
- QA/QC requirements
- Close coordination with designers and other trades earlier in the process
- New role as specialists, involved in detailing and design decisions at an early stage of process
Certificate Program: Structure and Philosophy

- Modular program for busy workplace learners
- Deliver theoretical information online
- Partnerships with software and machinery vendors and industry specialists
- Joint delivery of classroom-based learning with community colleges
- TDI serves as train-the-trainer hub for colleges
- Capstone “design-fabricate-build” experience at OSU’s new Emmerson Advanced Wood Products Lab
- Linkages with degree programs – wood science, engineering
- Links to schools to create career pathways to industry
- Partnerships with unions for hands-on skills training
<table>
<thead>
<tr>
<th>E-Learning</th>
<th>Community Colleges, Schools</th>
<th>Campus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intro to Mass Timber</td>
<td>CAD 2 &amp; 3</td>
<td>QA/QC</td>
</tr>
<tr>
<td>Intro to CAD and CNC</td>
<td>CNC 2 &amp; 3</td>
<td>Design-Fabricate-Build</td>
</tr>
<tr>
<td>Mass Timber Construction</td>
<td></td>
<td>Train-the-Trainer (CAD/CAM, CNC)</td>
</tr>
</tbody>
</table>
Mass Timber Construction E-learning Module

- E-learning module with short narrated/captioned videos and slideshows
- Visual learning for industry audience
- Content based on expertise of experienced industry specialists
- Case studies from US job sites (Peavy Hall, First Tech Credit Union, Brock Commons and others)
- Key topics: safety, surveying, rigging and lifting, connections, task sequencing, managing tolerances between trades, crane selection, placement and scheduling, logistics, moisture management...
Design skills
MOMENTUM

Danae Burck | Kelly Elmore | Cara Mitchell | Stefanie Wibiasa
Judith Sheine, Mark Donofrio, Faculty Advisors

Oregon State University
TALLWOOD DESIGN INSTITUTE
University of Oregon
THE LOOM

Wesley Miller | Garrett Mitchell | Jeffrey Toreson
Judith Sheine, Mark Donofrio, Faculty Advisors
Design Education
HISTORIC HAYWARD FIELD
MASS TIMBER WEST GRANDSTANDS

Judith Sheine
Department of Architecture
University of Oregon

Mikhail Gershfeld
Department of Civil Engineering
California State Polytechnic University, Pomona
Hayward Field
ARCH

Nicole Giustino | August Lehnert | Max Moore
Judith Sheine, Mikhail Gershfeld, Faculty Advisors
Open education
GLOBAL EXPERTS
Guided by the leading experts of the global wood industry.

OPEN ACCESS
Industry funding allows courses to be free and available to all.

SUPPORT LOCAL
Connection to local resources allow you to master what you've learned.

ACTIVE LEARNING
Curated courses are intuitive, engaging and interactive.

ONLINE RESOURCE
Fully accessible at home or on the go.

TRANSLATION
Learn in the language you are most comfortable in.
The future

• Greater need for collaboration and learning across the disciplines
• Conversation will evolve from “why” to “how” to “how to do it better”
• Lifelong learning and constant upskilling becoming the norm
• Flexible learning will be key
TALLWOOD

DESIGN INSTITUTE

Advancing solutions for designers, manufacturers and engineers of our built environment.

tallwoodinstitute.org
@tallwooddesign