MASS TIMBER DESIGN
PART 1: INVESTIGATIVE RESEARCH TOWARDS A 1:1 MASS TIMBER BUILDING PROTOTYPE
MIT WORKSHOP - ARCHITECTURE + URBANISM

Instructor: John Klein, j_klein@mit.edu
Credits: 3-0-9
Schedule: T + TH 9:30am – 11:00am
Location: TBD
Prerequisites: Permission of instructor

COURSE DESCRIPTION

With increasing demands placed on the planet through population growth and urbanization, energy remains one of the biggest challenges of the 21st century. Buildings are one of the largest consumers of global resources and all energy produced, and are primary contributors to greenhouse gases and solid wastes. At moment when the built environment is faced with dramatic shifts, the need for energy intelligent building prototypes is more significant than ever.

Mass Timber, a wood based building design and construction technology, has received attention over the last 30 years given its efficiency, speed, precision and versatility in construction for low to high-rise applications. The accelerated adaption of the technology additionally comes from its environmental benefits of low energy manufacturing, the buildings acting as carbon sinks through CO2 storage, and their high Lifecycle Analysis (LCA) profiles (lower emissions of greenhouse gases, less air and water pollution and lower waste).

North America is witnessing a “Mass Timber Movement,” with the completion of an 18 story tower in British Columbia, a 7 story tower completed in Minnesota, and a recently approved 12 story tower in Oregon, amongst numerous other projects. Mass timber technology is currently being integrated into the International Building Code (IBC) through recent successful fire and seismic testing. With Boston’s anticipated building demand over the next 20 years, organizations are investigating resources in New England for local production of mass timber products. The goal of the workshop is to equip participants with the technical knowledge of mass timber systems, and work collectively to conduct investigative research towards a 1:1 building prototype for Boston at the intersection of design, engineering and science.

A foundation of mass timber technology will be provided through in class lectures, video conference lectures, invited guest lectures and visits. The combination of the different formats aims to integrate the course with progressive members from industry. The fall workshop is the first in a two part series that works towards the production of a real building project. The workshop encourages a cross-disciplinary research domain, and welcomes participation of students from all departments & discipline groups.
The workshop is organized in three modules that build upon each other: 1) Analysis, 2) Systems, and 3) Design.

**Module 1: Mass Timber Analysis**
The first module is an in-depth analysis on important domains of mass timber to reveal design opportunities for novel contributions. Participants will select a research domain to contribute to the matrix of mass timber knowledge for the course (in groups). Research efforts should focus on abstracting core concepts relevant to architectural production, and should avoid excessive technical content. Research domains include, but are not limited to the following:

1. **Material**
   a. Wood science
      i. Species (applicable to a low-rise building), uses, properties
      ii. Structure of wood (tree anatomy)
      iii. Tree growth
      iv. Softwoods & hardwoods
    b. Forestry, harvesting, certified wood
2. **Manufacturing**
   i. Processing (Lumber + Mills)
   ii. Products (Glulam + CLT)
   iii. Technologies: Cutting, sawing, etc. (Analogue and digital)
   iv. Transportation
3. **Methods**
   a. Construction methods
      i. Glulam Post and beam
      ii. Cellular CLT panels
      iii. Volumetric prefabrication
      iv. Long span structures, large beams
    b. Joinery, connections, details
    c. Mass timber building enclosure systems (materials, details, general strategies etc.)
4. **Masters**
   a. Historical applications of Heavy Timber (Asian temples, British boat building, etc.)
   b. Notable mass timber case studies

**Output**
- Research presentation booklet that paints the narrative of where the 1:1 building project is situated.
Module 2: Mass Timber Systems
The second module will evolve the research into unique architectural systems through the supplied design constraints. We will work through the production of digital and physical scaled models, and 1:1 system prototypes. Participants will be exposed to iterative design pipelines and free-form mesh modelling using Autodesk Maya + Rhino + Grasshopper. Potential research areas include, but are not limited to the following:

- Articulating mass timber roofs for natural daylighting
- Vaulted, pleated, ribbed and folded plate systems CLT load-bearing applications
- Digital CLT joinery (Multi-axis joint articulations)
- Lightweight, high-performance envelopes for mass timber superstructures

Output
- Physical model demonstrating system sophistication
- Detail Prototype (demonstrating important interfaces)
- PDF booklet demonstrating system capacity

Module 3: Mass Timber Design
In the third module we will select a direction and develop the approach into an architectural design concept. The final design will be documented in a concept booklet, curated into an exhibition, and published collectively. The output will be utilized to progress the design forward towards a real building project.

Output
- Models: Physical model of design
- Mock-up: 1:1 Mock-up of system
- Drawings: General, sections and important system details
- Renderings: Exterior and interiors views
- Building Quantity & Cost Analysis
- PDF booklet demonstrating the design