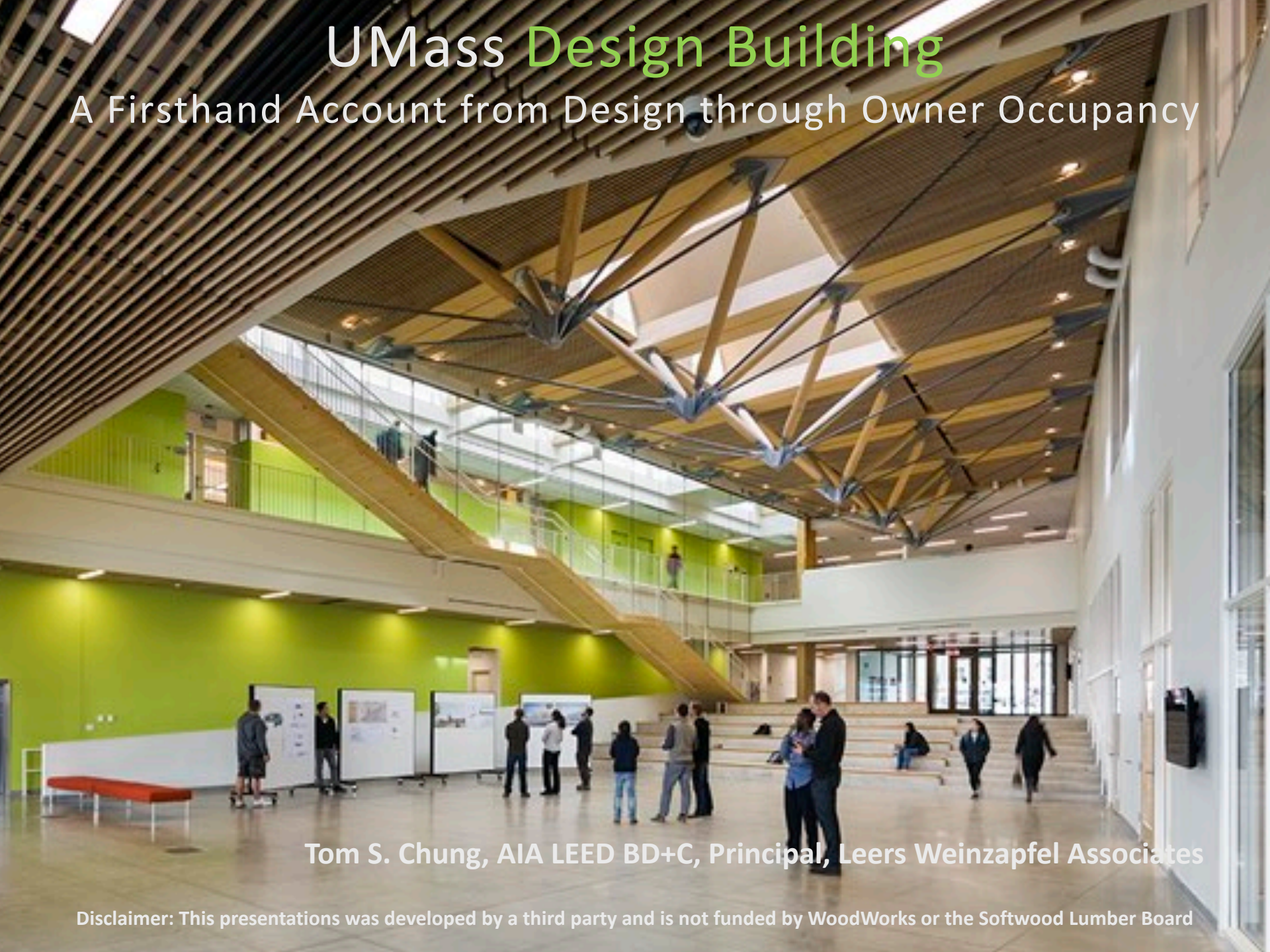
UMass Design Building

A Firsthand Account from Design through Owner Occupancy



Tom S. Chung, AIA LEED BD+C, Principal, Leers Weinzapfel Associates

LEERS WEINZAPFEL ASSOCIATES

LEERS WEINZAPFEL ASSOCIATES

Design Distinction

National AIA Firm Award

Ranked in ARCHITECT Magazine's Top 50 Firms, 2015-2018

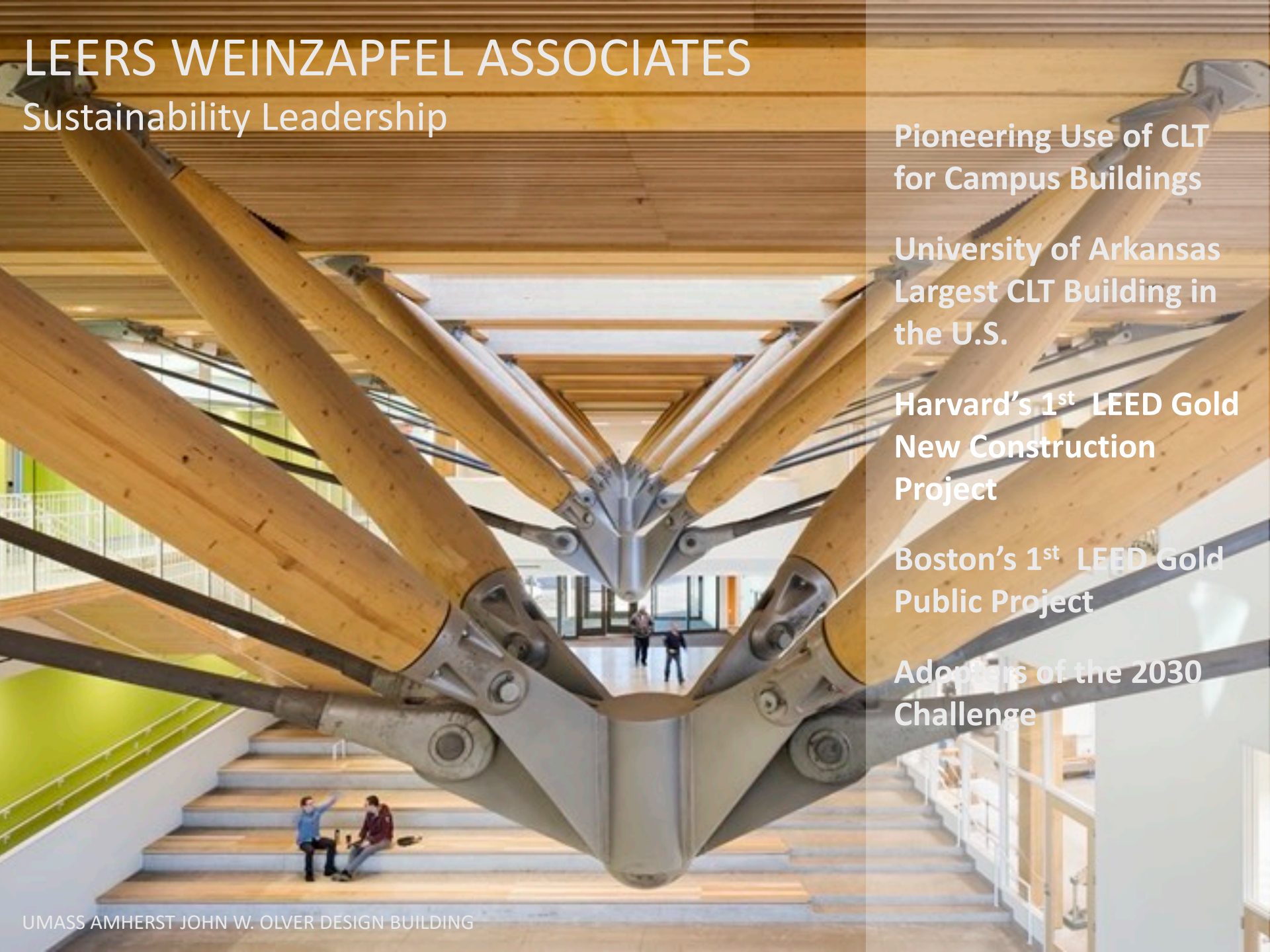
Over 95 National & Regional Design Award

Over 100 National & International Publications

UMASS AMHERST JOHN W. OLVER DESIGN BUILDING

LEERS WEINZAPFEL ASSOCIATES

Sustainability Leadership



Pioneering Use of CLT for Campus Buildings

University of Arkansas Largest CLT Building in the U.S.

Harvard's 1st LEED Gold New Construction Project

Boston's 1st LEED Gold Public Project

Adopters of the 2030 Challenge

UMASS AMHERST JOHN W. OLVER DESIGN BUILDING


JOHN W. OLVER
DESIGN BUILDING

UMass Design Building

A Firsthand Account from Design through Owner Occupancy

- "The Wood Products Council" is a Registered Provider with The American Institute of Architects Continuing Education Systems (AIA/CES), Provider #G516.

- Credit(s) earned on completion of this course will be reported to AIA CES for AIA members. Certificates of Completion for both AIA members and non-AIA members are available upon request.

- This course is registered with AIA CES for continuing professional education. As such, it does not include content that may be deemed or construed to be an approval or endorsement by the AIA of any material of construction or any method or manner of handling, using, distributing, or dealing in any material or product.

- Questions related to specific materials, methods, and services will be addressed at the conclusion of this presentation.

Tom S. Chung, AIA LEED BD+C, Principal, Leers Weinzapfel Associates

UMass Design Building

A Firsthand Account from Design through Owner Occupancy

Course Description

Completed in early 2017, the Design Building at the University of Massachusetts Amherst is the first of its kind in the U.S. At four stories and 87,500 sf, this mass timber project features a glued-laminated (glulam) timber column-and-beam frame, mass timber lateral force-resisting system, hybrid cross-laminated timber (CLT)/concrete floor system, and unconventional cantilevered forms.

This presentation will highlight two aspects of the project: the design process will be discussed by the principal architect and the construction and occupancy phases will be reviewed by an associate professor who was close to the process and now works in the building. From code approval through occupancy, this session will address the process and collaboration required to see this groundbreaking structure to fruition in a steel-dominated construction industry.

Tom S. Chung, AIA LEED BD+C, Principal, Leers Weinzapfel Associates

UMass Design Building

A Firsthand Account from Design through Owner Occupancy

Learning Objectives

- Explore the design team's approach to material and construction selection for a mass timber building in lieu of traditional steel systems.

- Review the code approvals and procurement steps taken to achieve compliance for and construction of a first-of-its-kind mass timber building.

- Highlight innovative structural solutions such as composite CLT floor systems, researched at the University and implemented by the design team.

- Demonstrate the benefits realized by tenants of a mass timber building including aesthetics and occupant comfort.

Tom S. Chung, AIA LEED BD+C, Principal, Leers Weinzapfel Associates

UMass Design Building

A Firsthand Account from Design through Owner Occupancy

AGENDA/ OUTLINE

Introduction
- Background, Context, & Design Concept

Design Process
- Structure & Architecture
- Central Commons
- Assuring the Client: Budget, Procurement & Code

Construction
- Mass Timber compared to Steel Construction
- Post&Beam Construction, Composite Floors, Shaft Walls, & Bracing
- Zipper Truss Mid-air Assembly

Occupancy Phase and Benefits of Mass Timber
- User Experience and Intangibles of Wood and Architecture
- Forestry & Sustainability Benefits

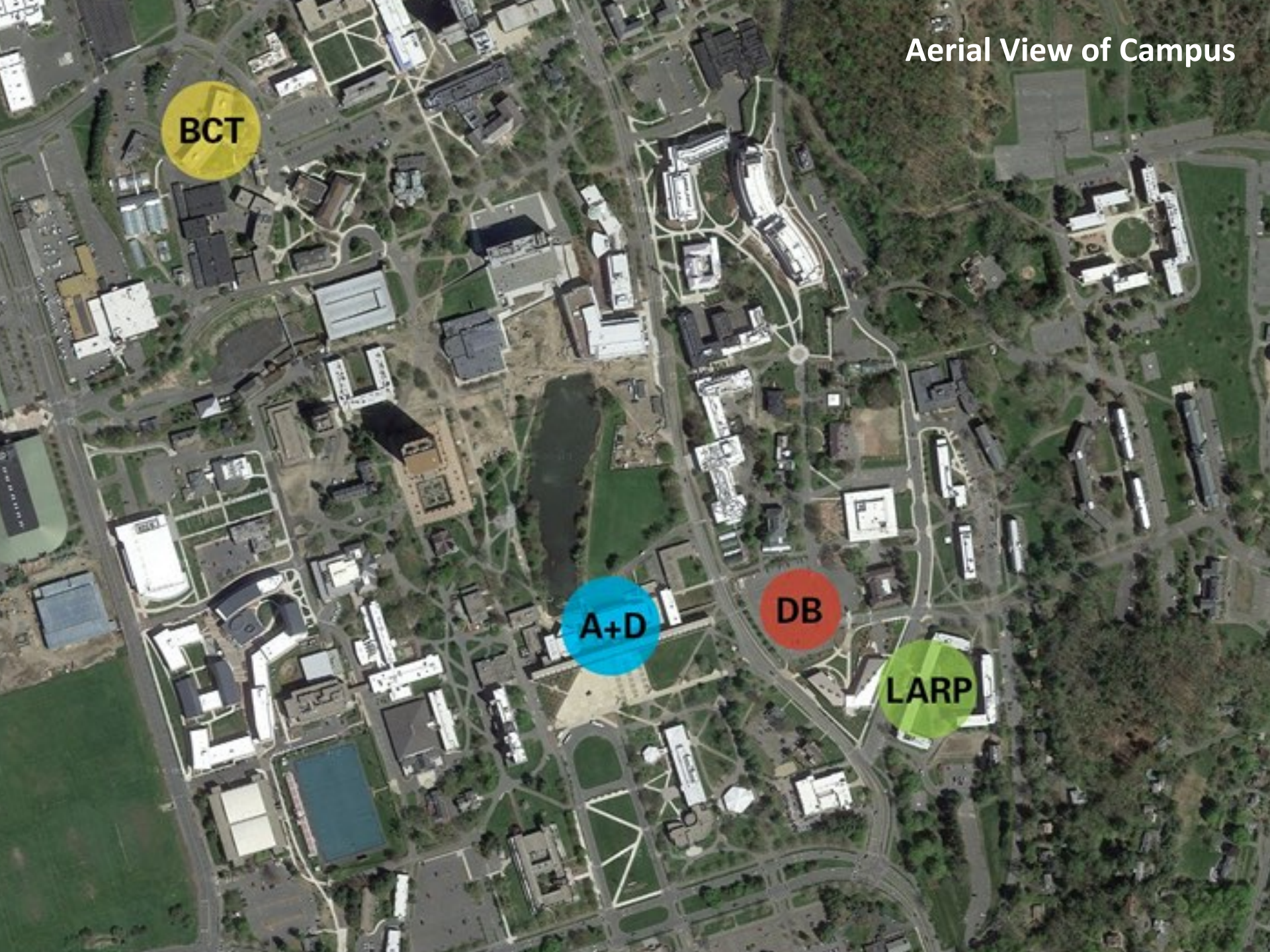
Tom S. Chung, AIA LEED BD+C, Principal, Leers Weinzapfel Associates

Project Background
&
Design Concept

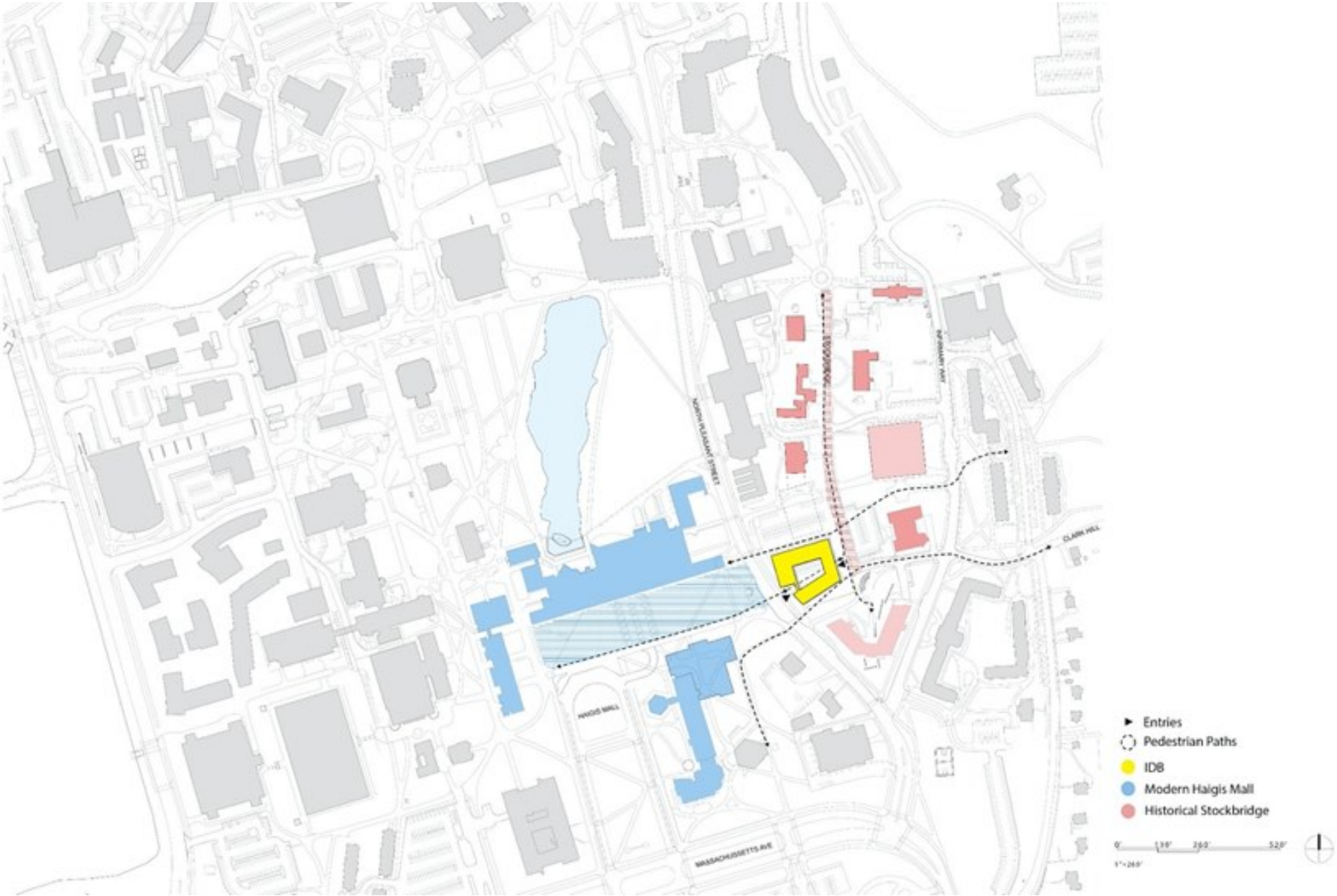
Regional Context

View of campus at upper left, from Connecticut River

Aerial View of Campus



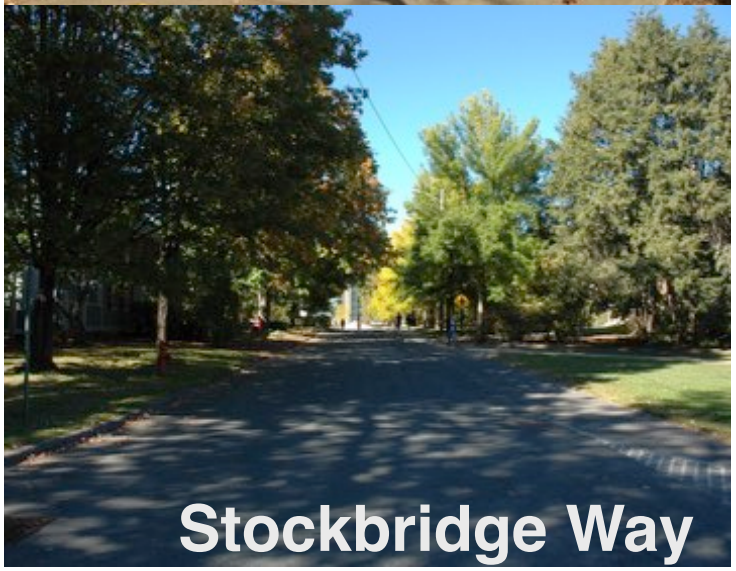
Campus Circulation



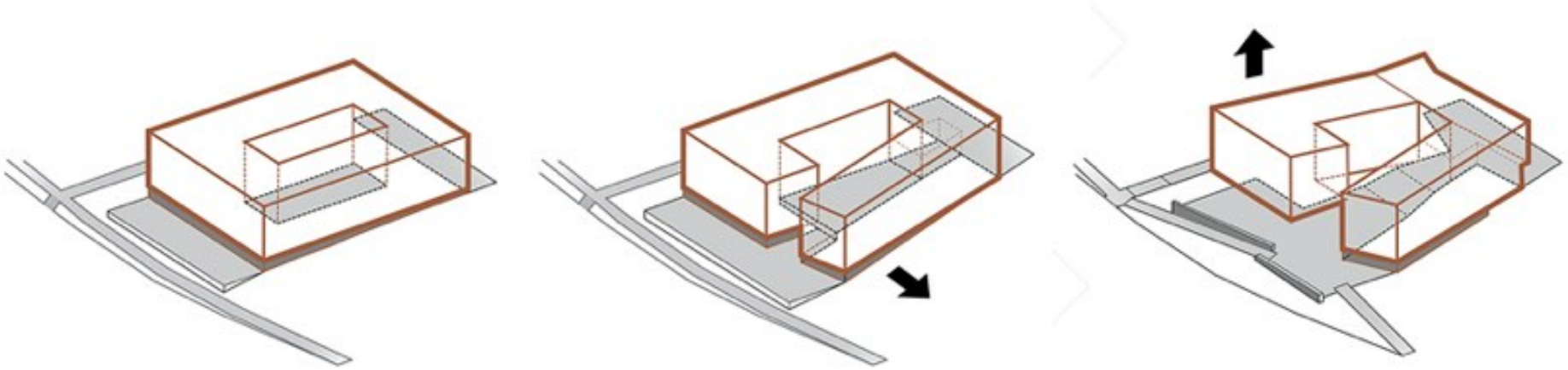

UNIVERSITY CLU

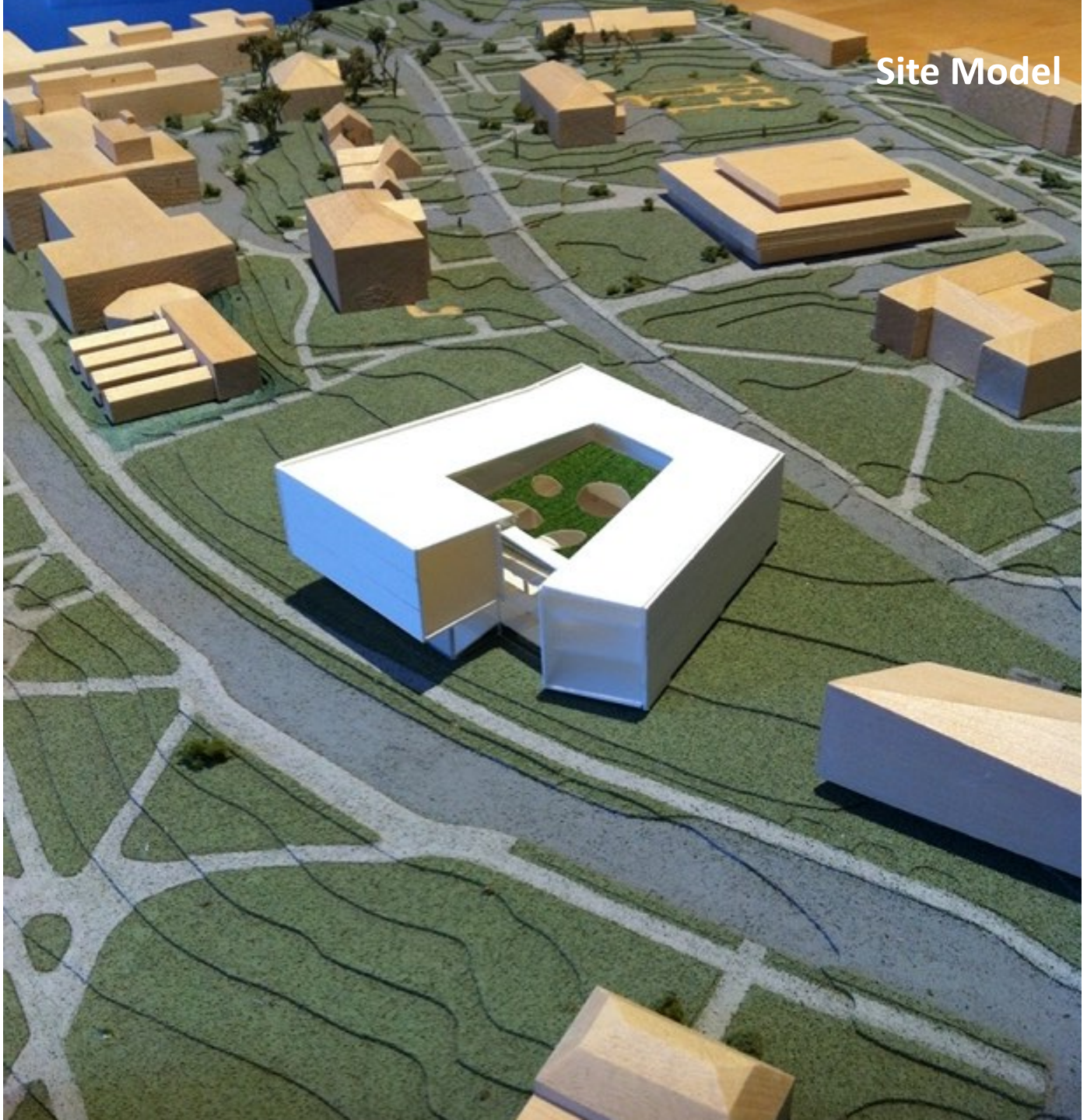

Context


Haigis Mall

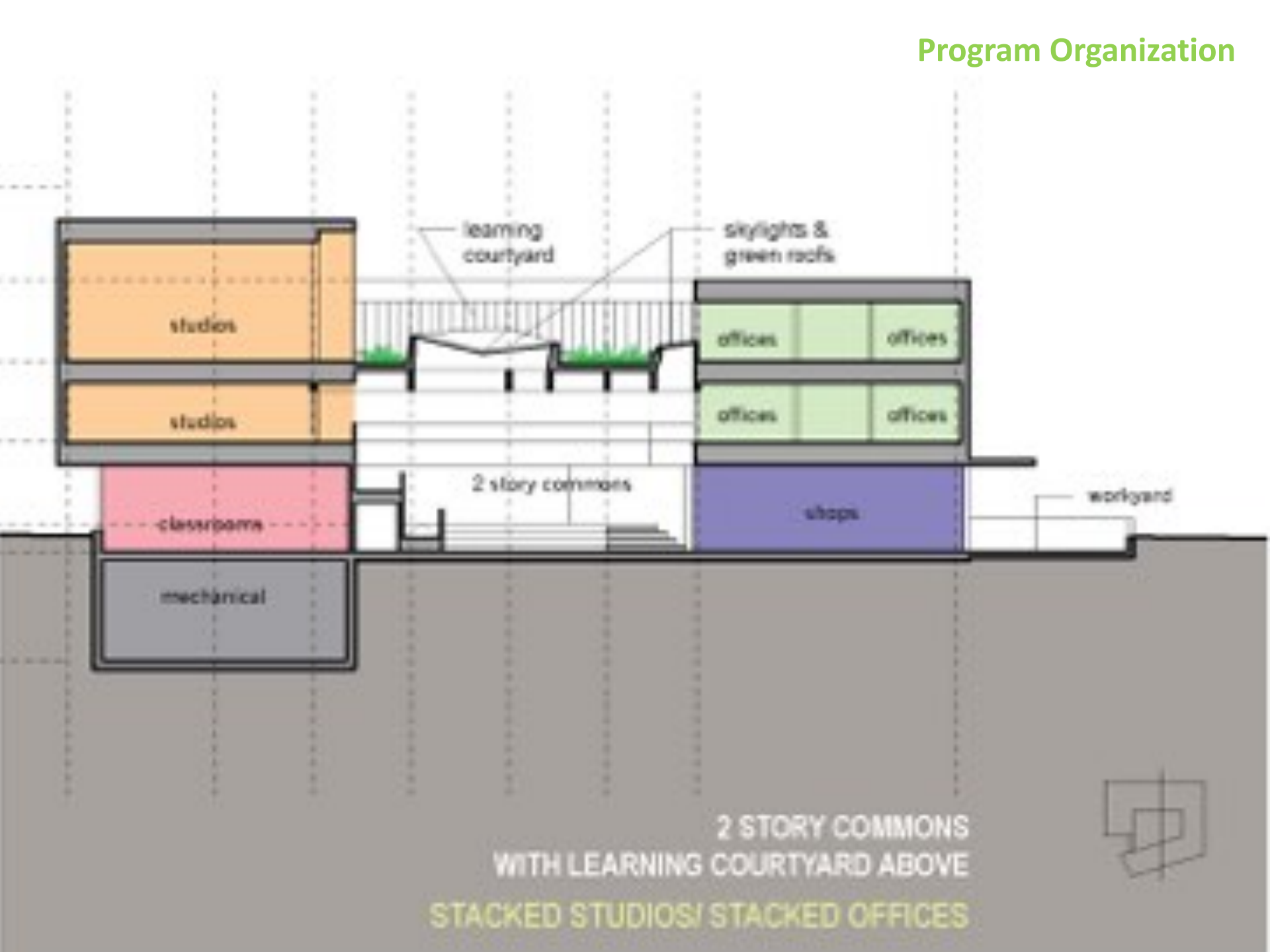

Stockbridge Way

Building Concept Diagram




Site Model

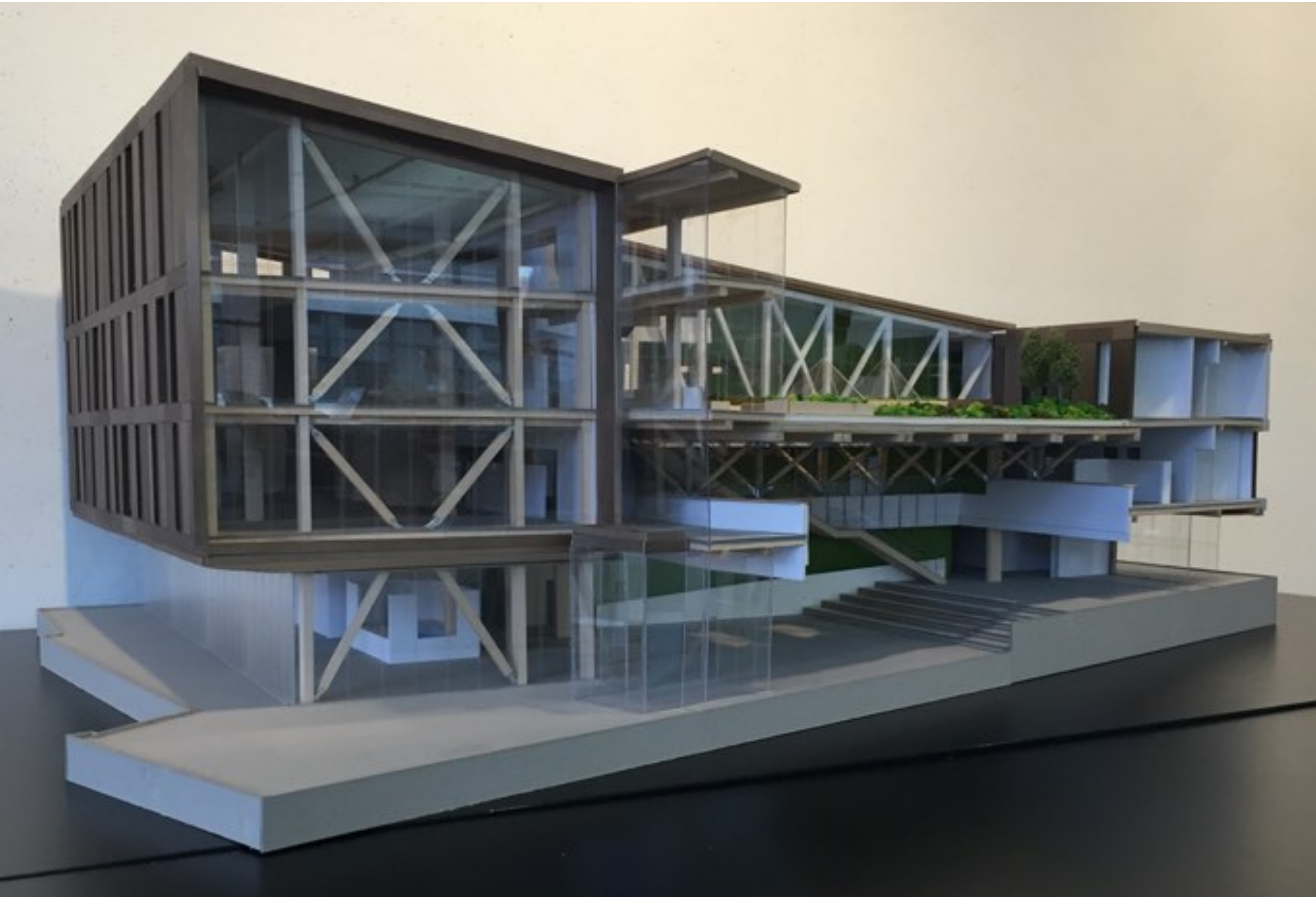
Program Organization



Section Through Commons and Learning Courtyard

Section Perspective

Cutaway Model

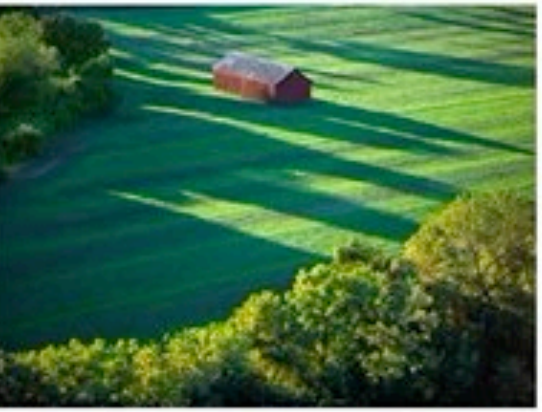
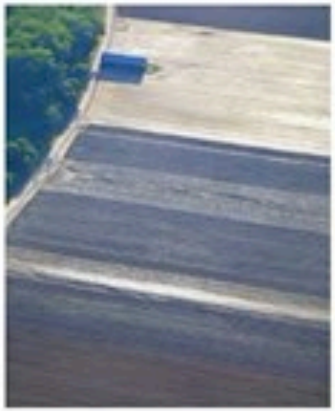


Central Commons

Learning Courtyard

Regional Context







View from Campus Core

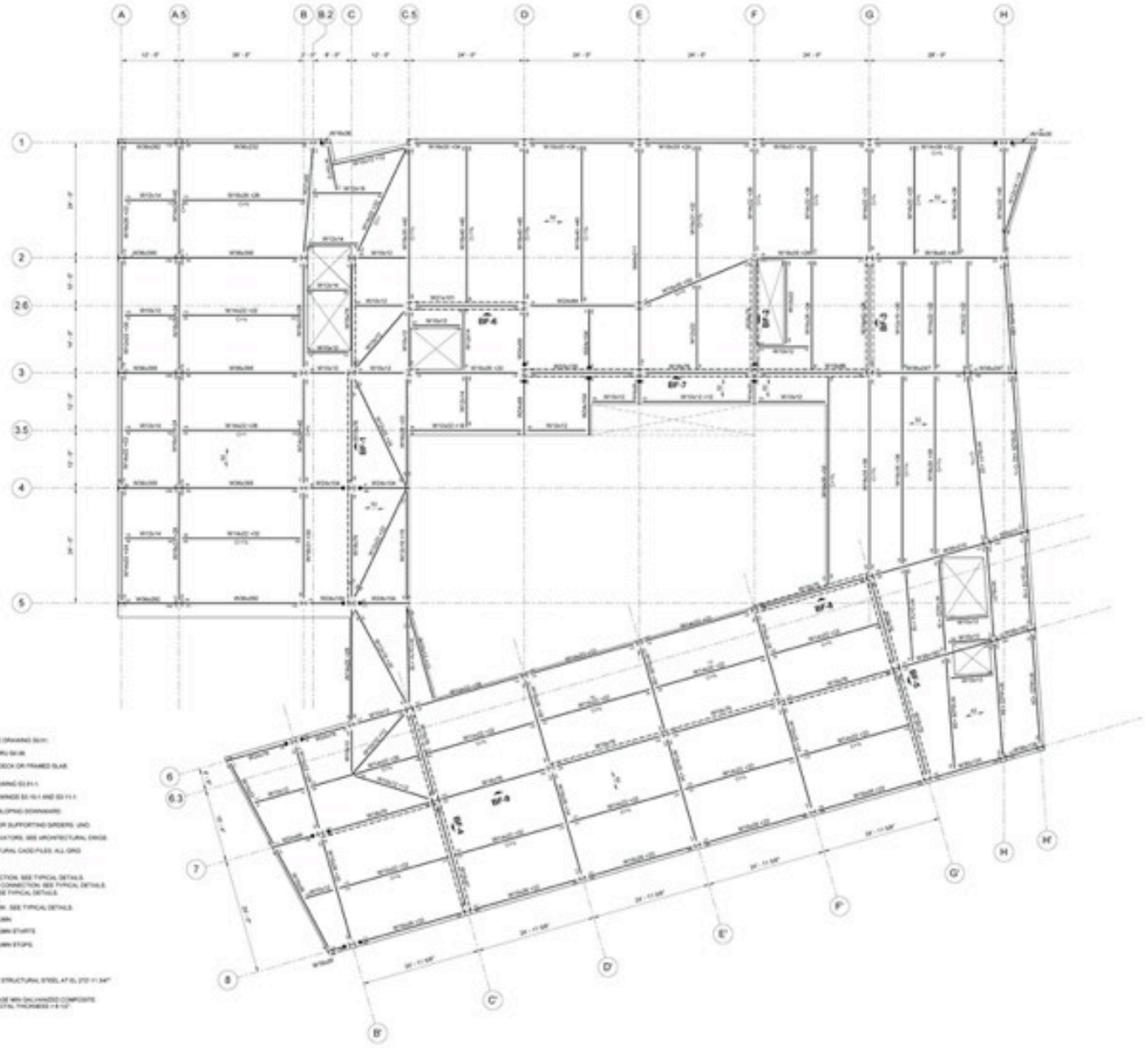
View from Historic Stockbridge Way


View from North Approach

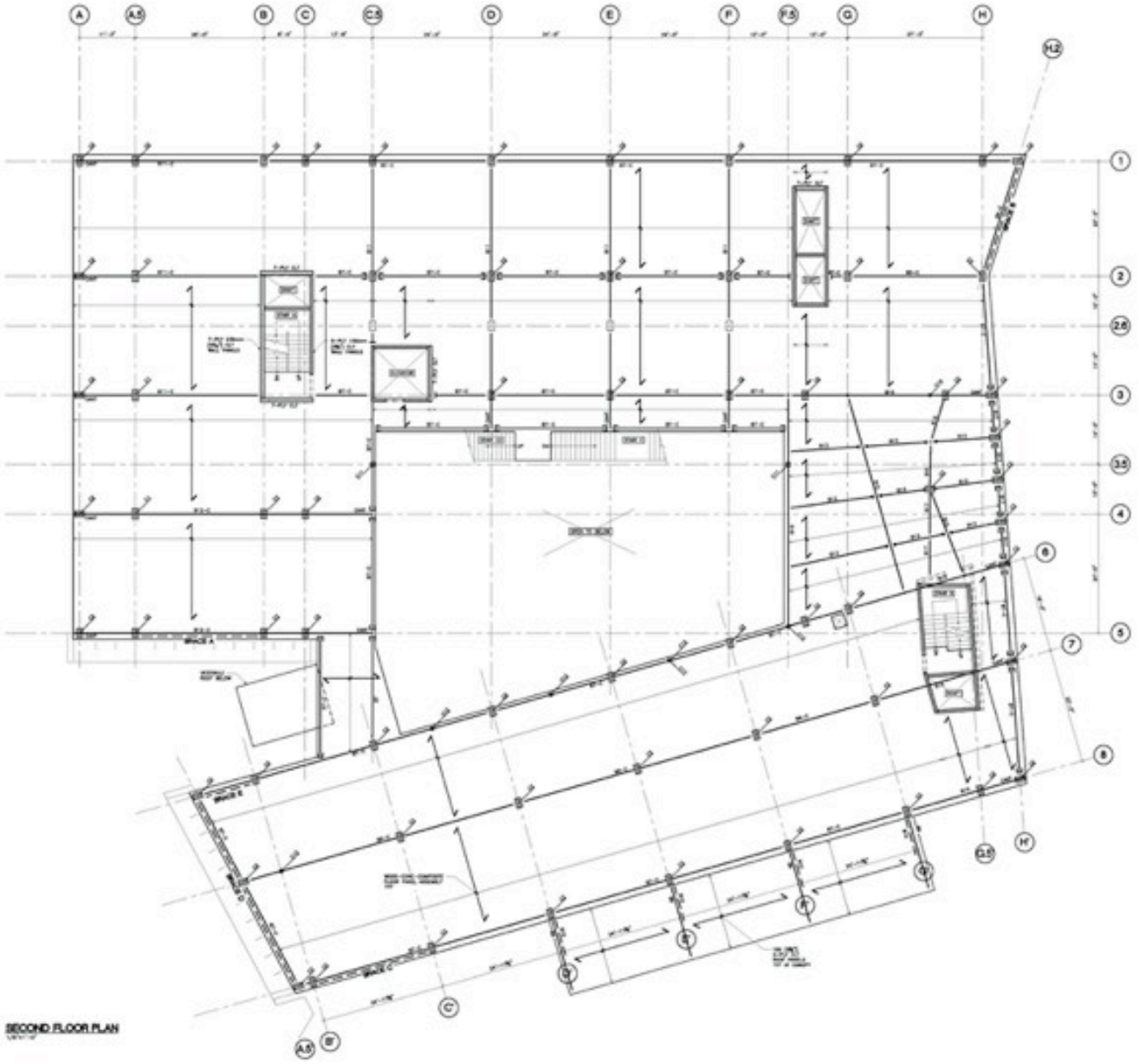
Design Process

Typical Floor Plan

Steel Column Grid



Timber Column Grid



SECOND FLOOR PLAN

TYPICAL WOOD-CONCRETE COMPOSITE FLOOR ASSEMBLY

BEAM SCHEDULE

MARK	MATERIAL	TYPE & SIZE	REMARKS
B1	WOOD		
B2	WOOD		
B3	WOOD		
B4	WOOD		
B5	WOOD		
B6	WOOD		
B7	WOOD		
B8	WOOD		
B9	WOOD		
B10	WOOD		
B11	STEEL		
B12	STEEL		
B13	STEEL		
B14	STEEL		
B15	STEEL		
B16	STEEL		
B17	STEEL		

COLUMN SCHEDULE

MARK	MATERIAL	TYPE & SIZE	REMARKS
C1	WOOD		
C2	WOOD		
C3	STEEL		
C4	STEEL		
C5	STEEL		
C6	STEEL		

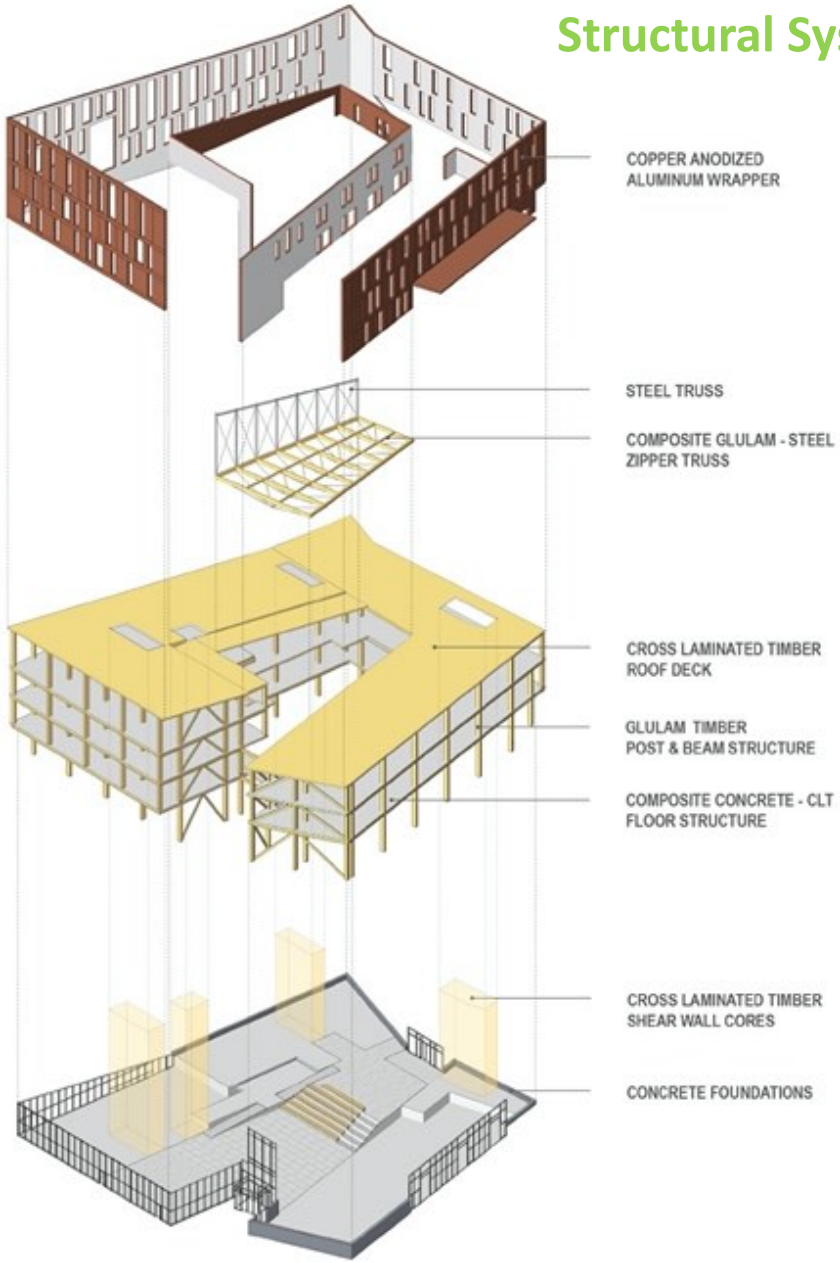
EQUILIBRIUM

UMASS INTEGRATED DESIGN BUILDING
University of Massachusetts
Amherst, MA

UMBA PROJECT #12-A3
UMASS BUILDING #720

SECOND FLOOR PLAN
S102

Structural Systems



CLT

GLULAM

NLT

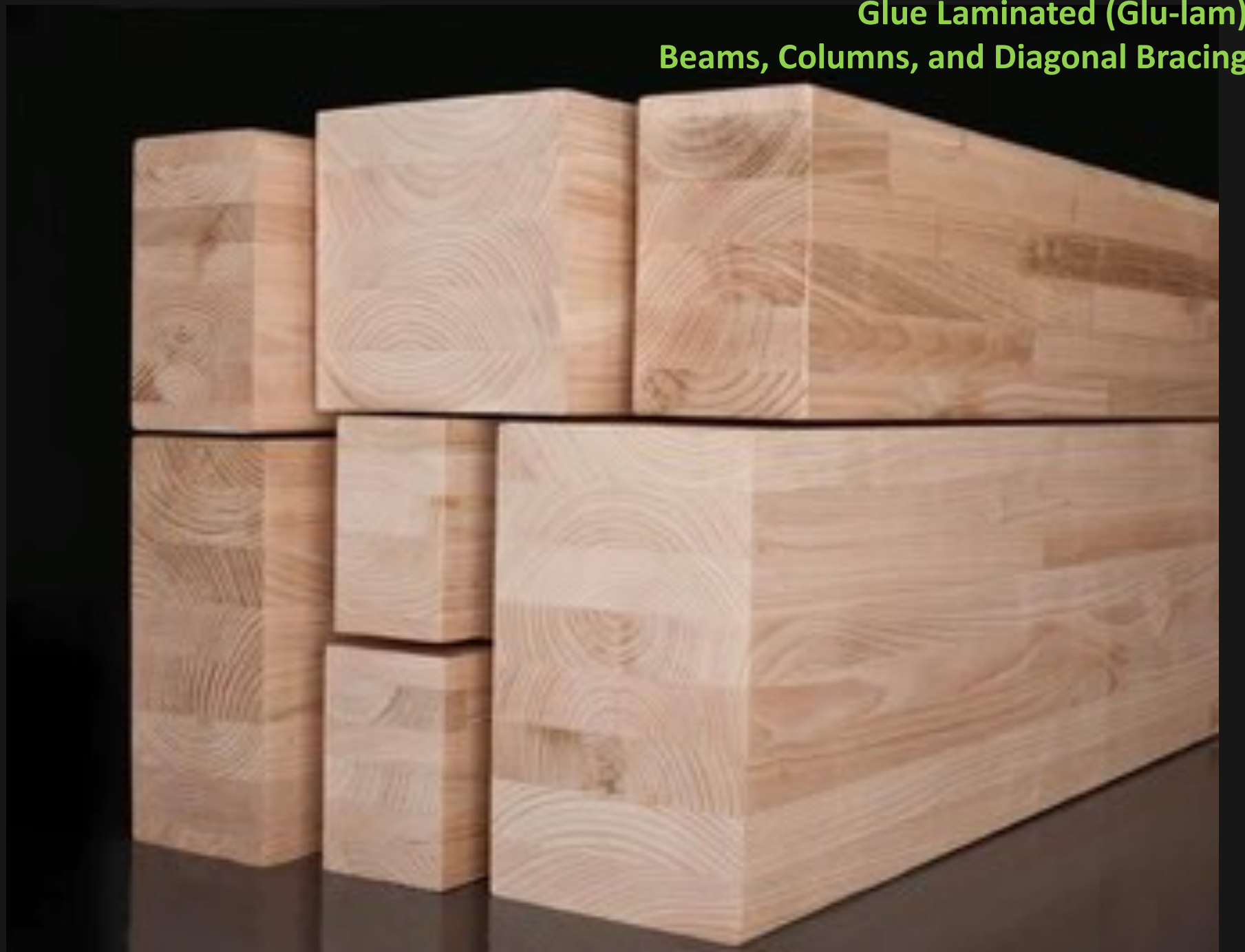
DLT

LVL

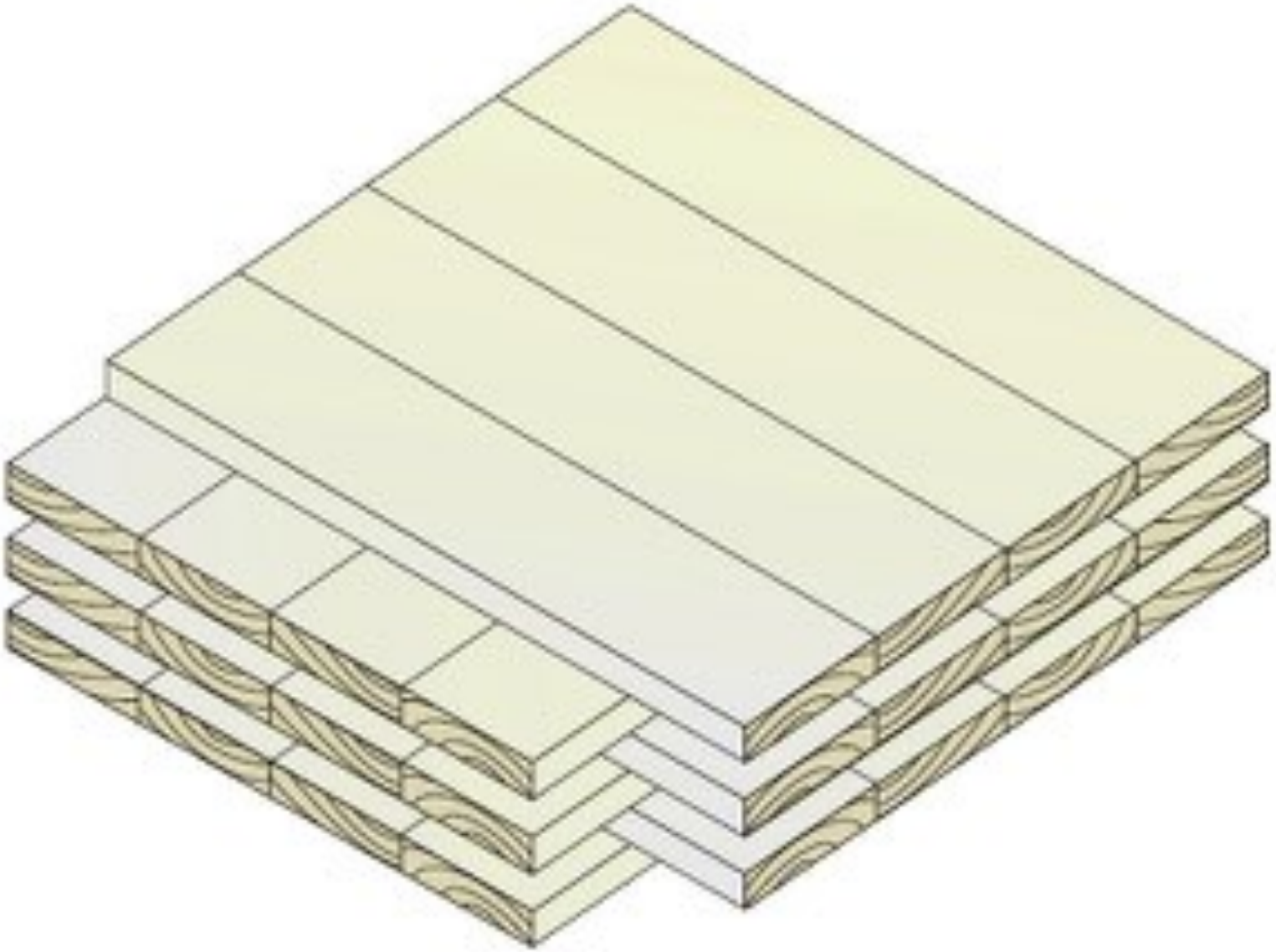
LSL

PSL

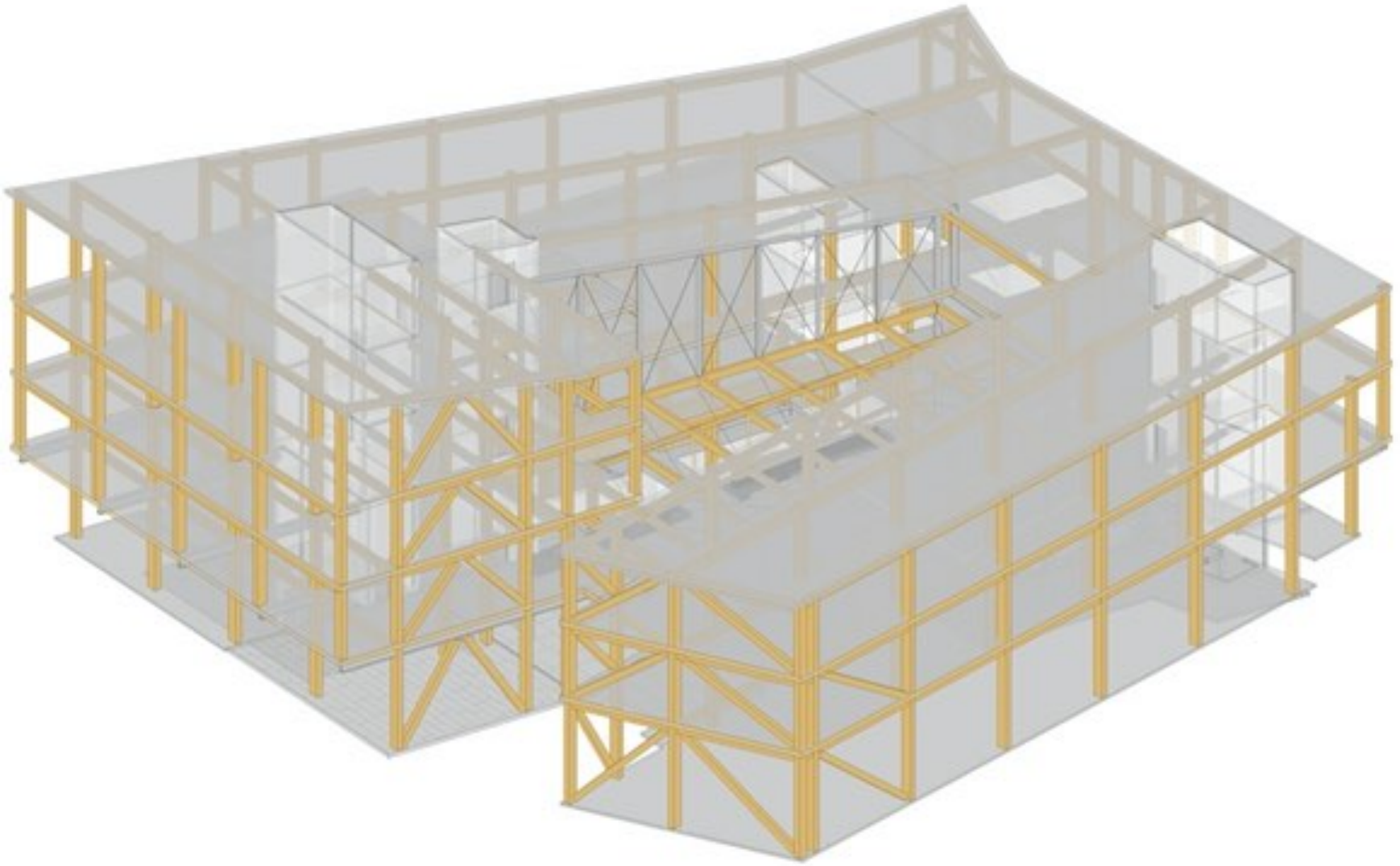
MPP

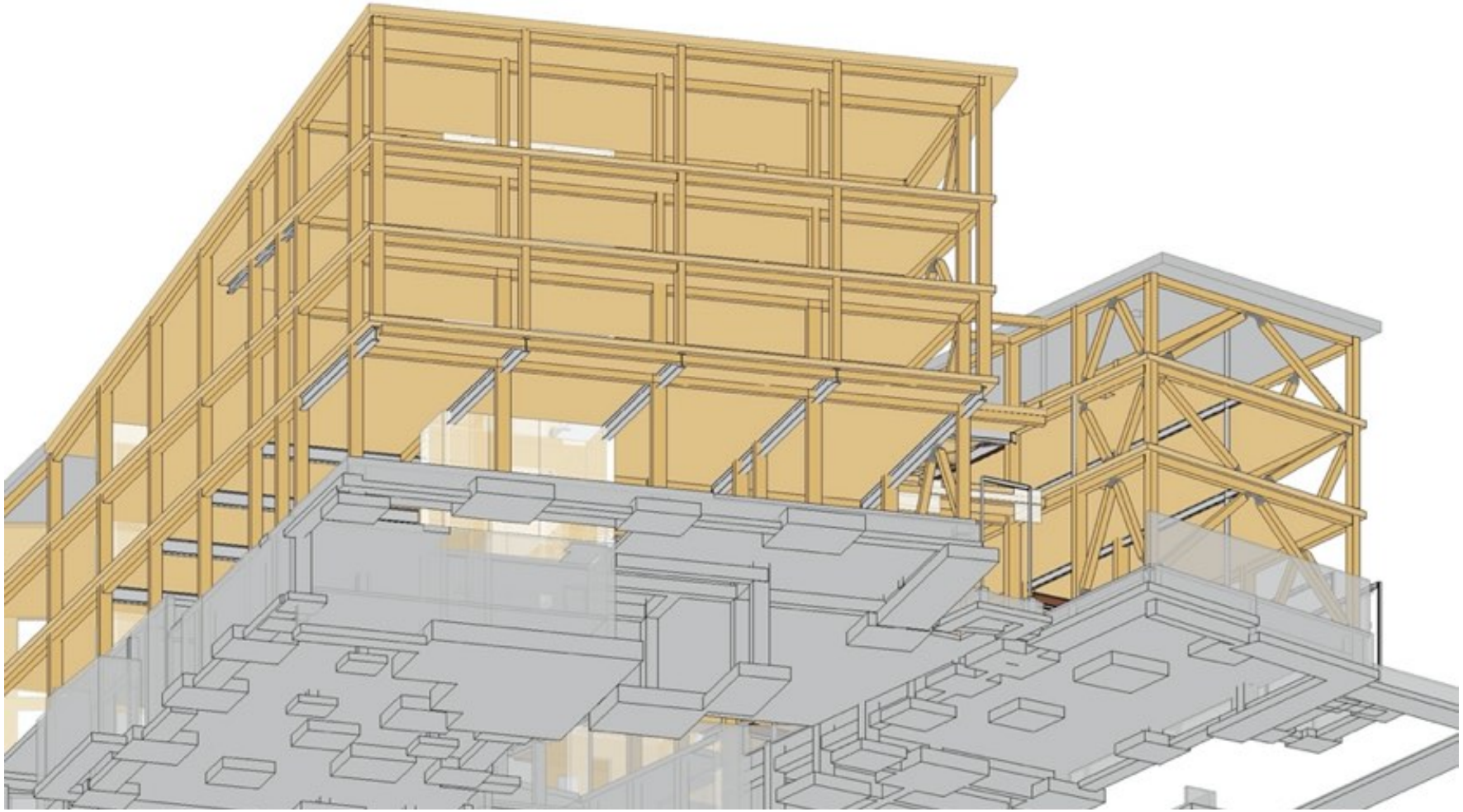

Glue Laminated (Glu-lam)
Beams, Columns, and Diagonal Bracing

Cross Laminated Timber (CLT) for Floor Panels and Shear Walls



Post and Beam Structural Framework





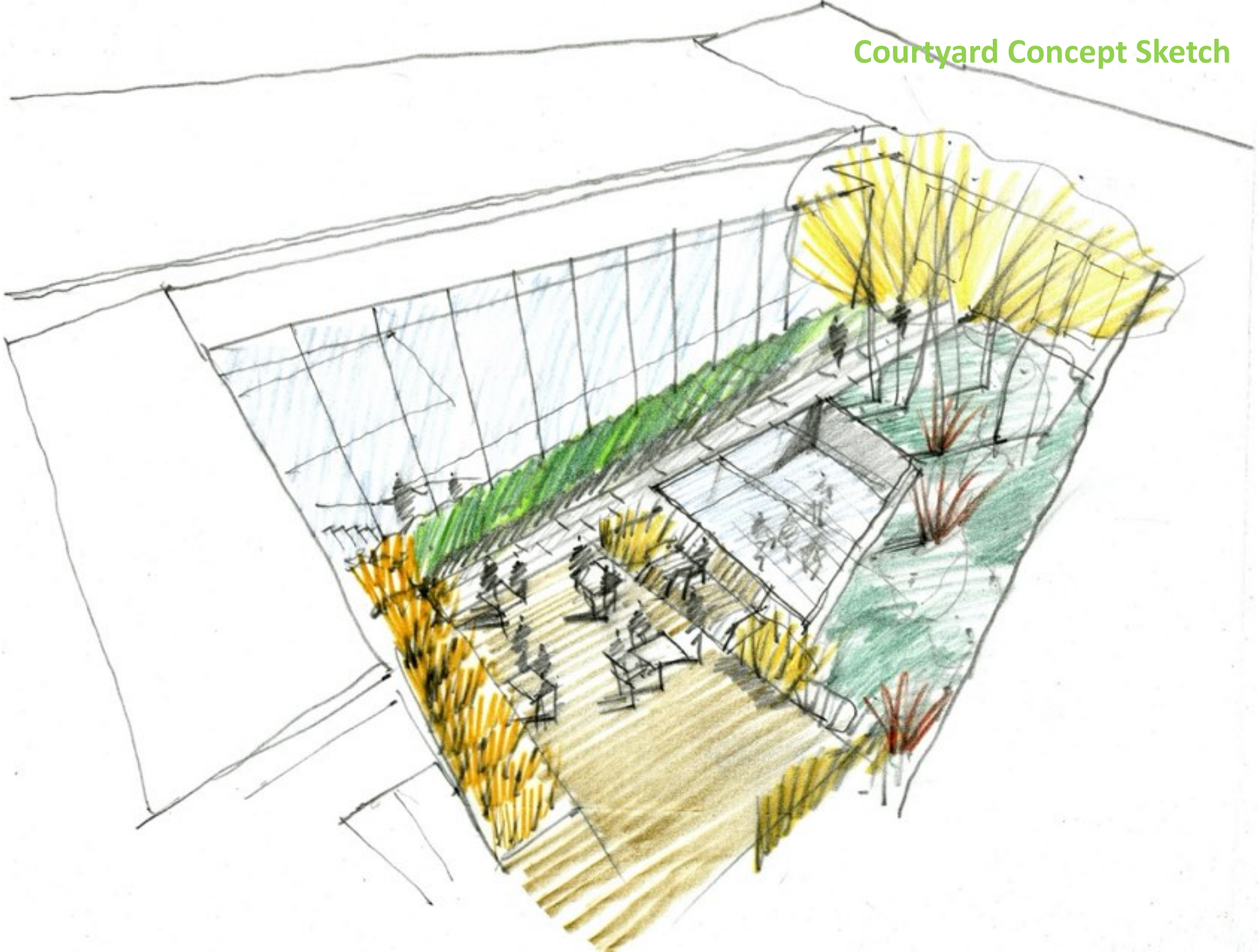
Revit Model

Central Commons and Courtyard Design

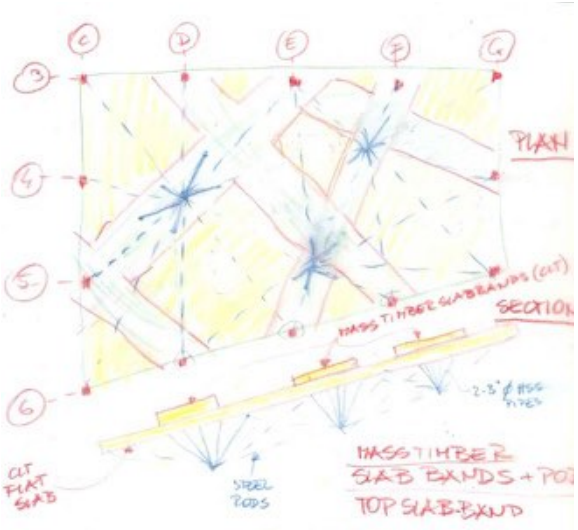
Structural Challenges:

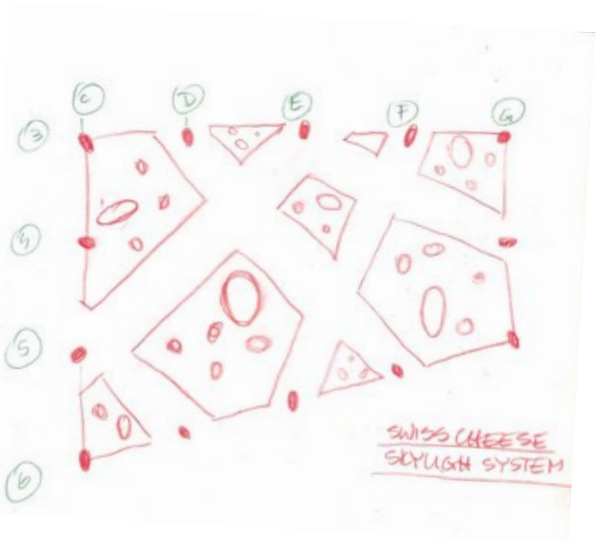
- **Longest span with heavy loading above**
- **Minimize structural depth**
- **Wet garden on a wood structure**

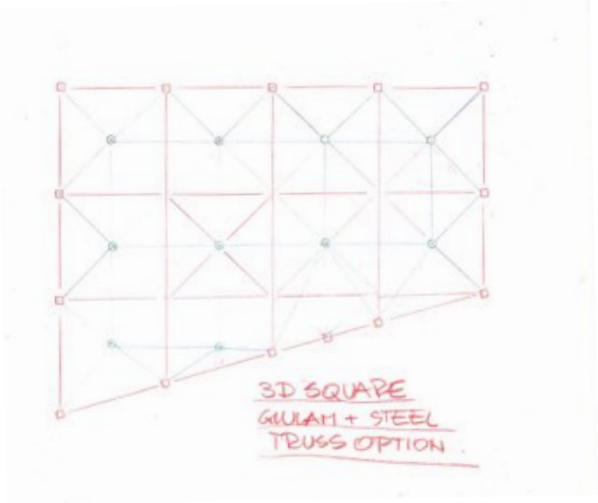
Courtyard Concept Sketch

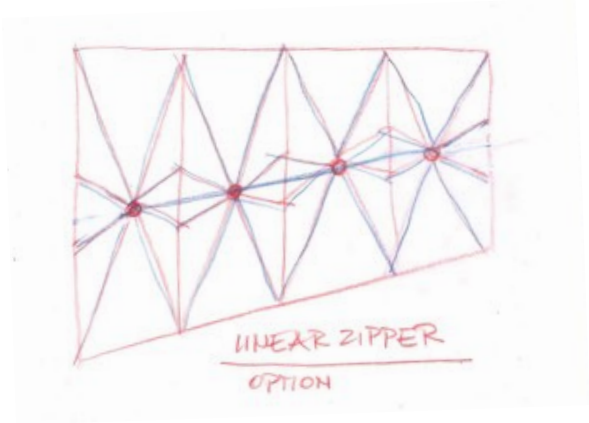


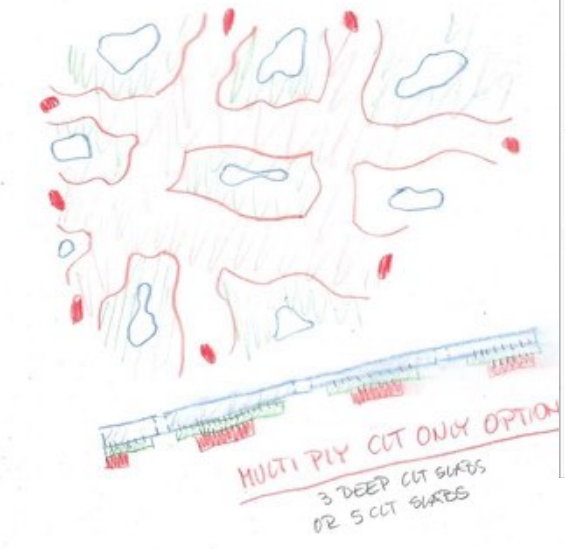
Central Space Structural Concepts

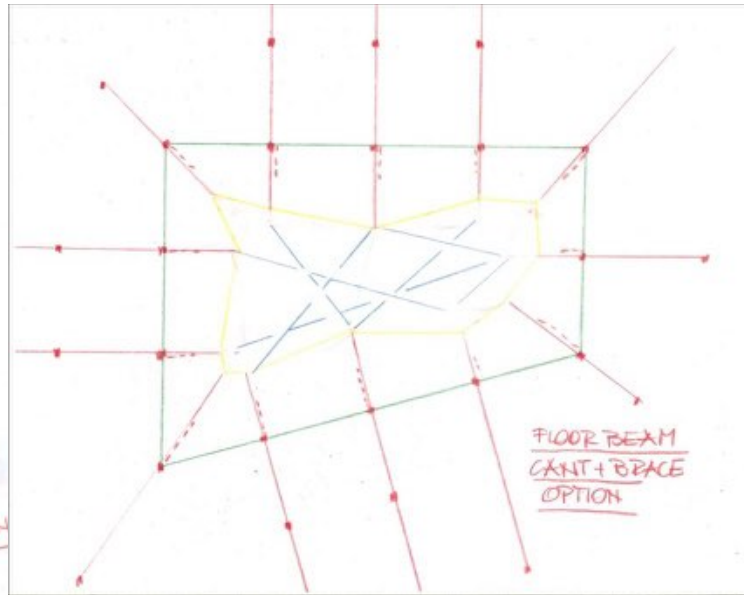




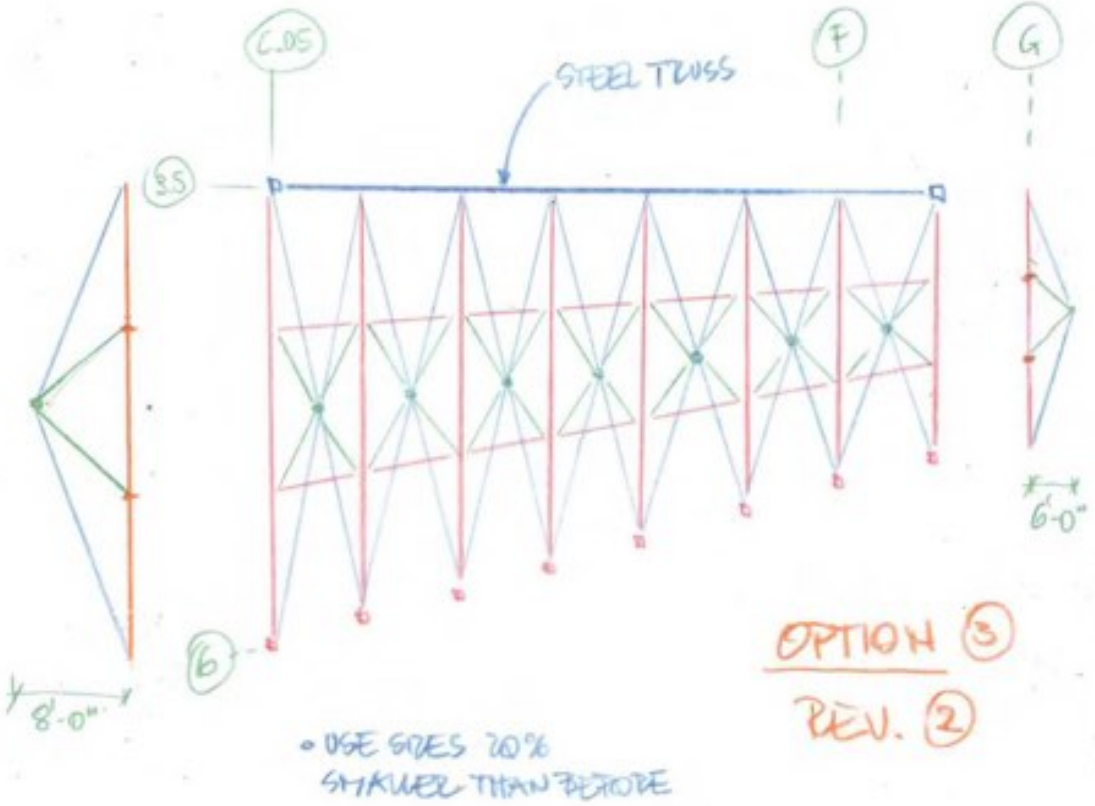




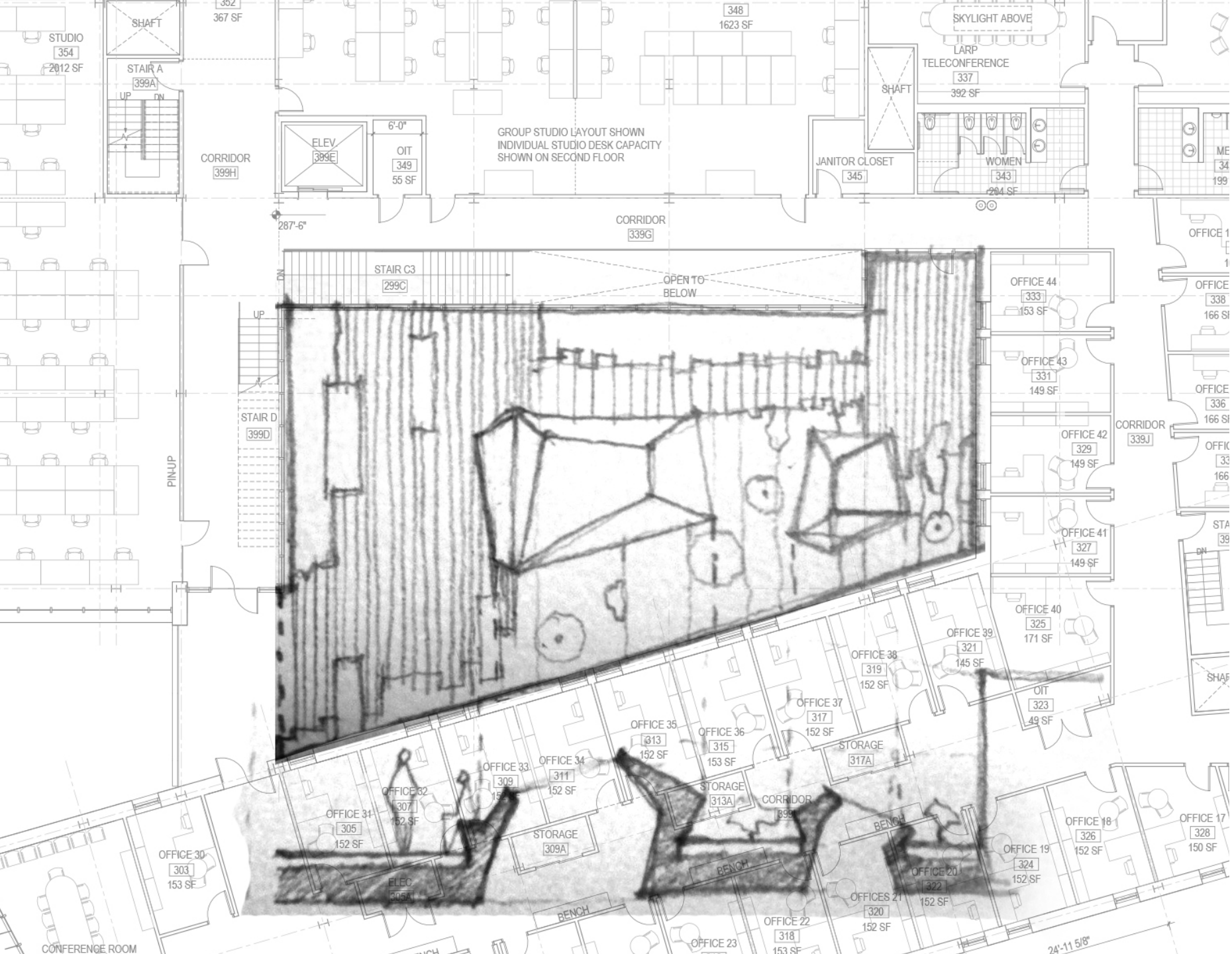


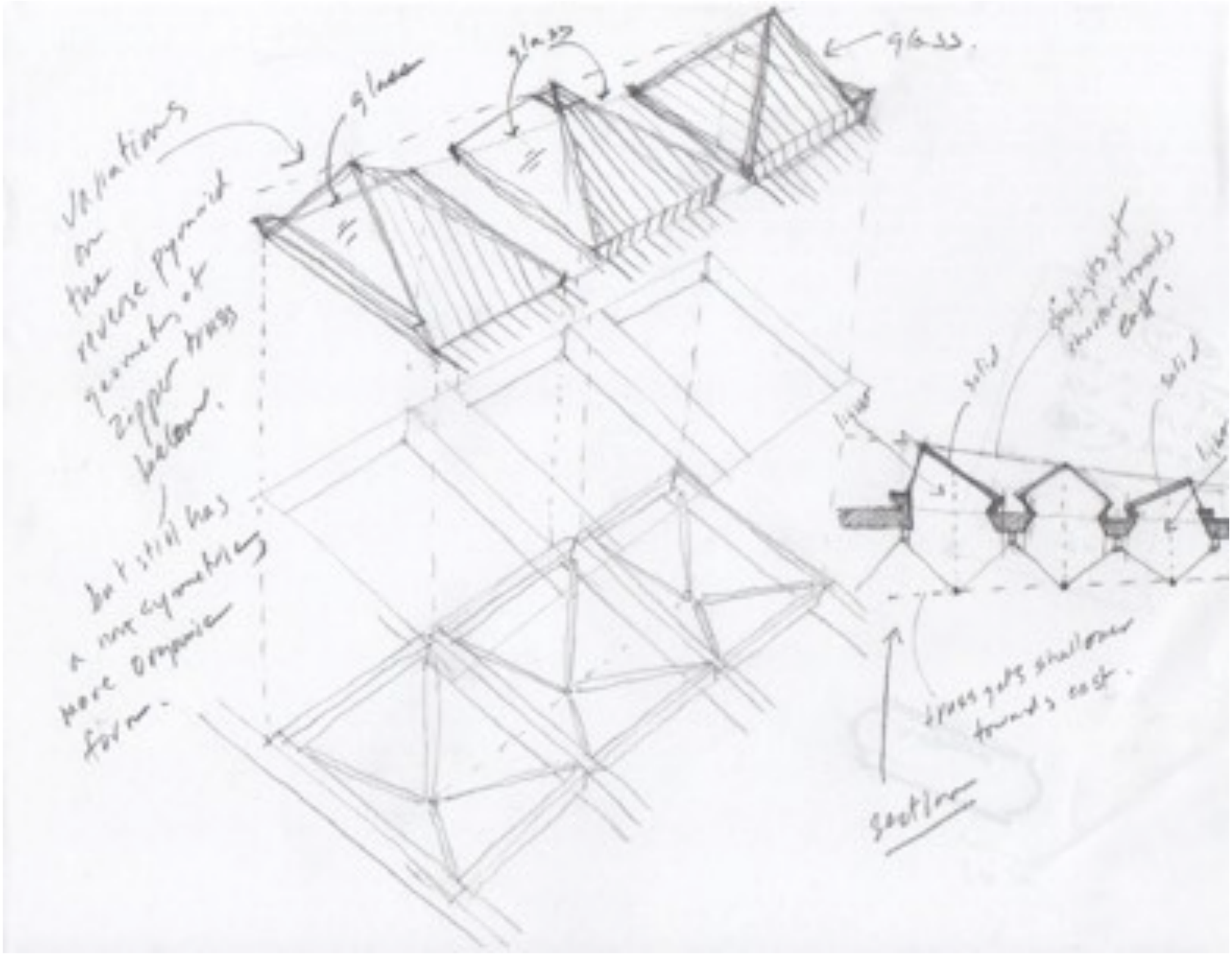


Zipper Truss Final Concept



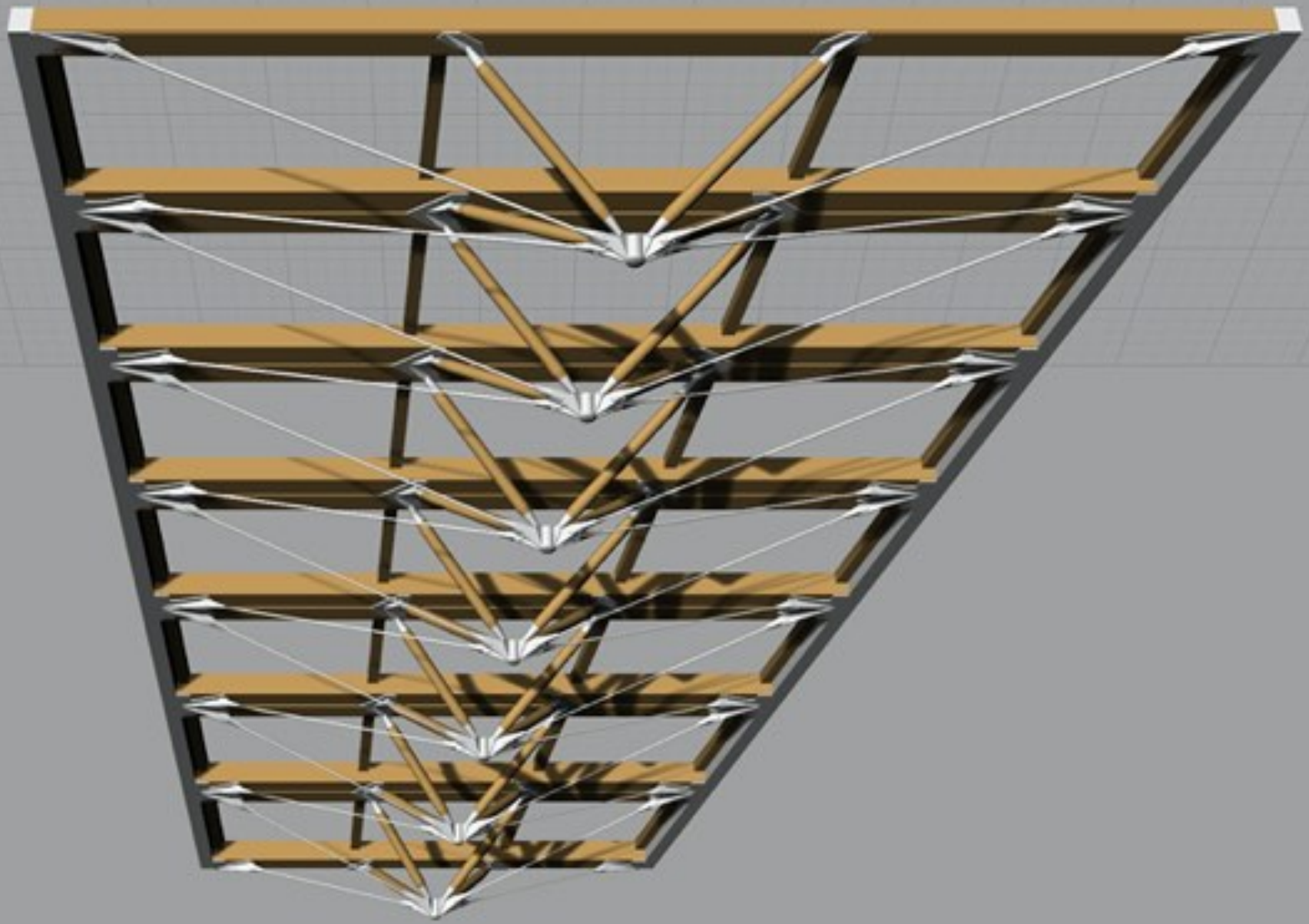
Zipper Truss Model


STUDIO
354
2012 SF
SHAFT
352
367 SF
STAIR A
399A
UP
DN
CORRIDOR
399H
ELEV
399E
6'-0"
OIT
349
55 SF
GROUP STUDIO LAYOUT SHOWN
INDIVIDUAL STUDIO DESK CAPACITY
SHOWN ON SECOND FLOOR
287'-6"
348
1623 SF
SKYLIGHT ABOVE
LARP
TELECONFERENCE
337
392 SF
SHAFT
JANITOR CLOSET
345
WOMEN
343
204 SF
CORRIDOR
339G
STAIR C3
299C
DN
OPEN TO
BELOW
UP
STAIR D
399D
PIN-UP
OFFICE 44
333
153 SF
OFFICE 43
331
149 SF
OFFICE 42
329
149 SF
CORRIDOR
339J
OFFICE 41
327
149 SF
OFFICE 40
325
171 SF
OFFICE 39
321
145 SF
OFFICE 38
319
152 SF
OFFICE 37
317
152 SF
OIT
323
49 SF
OFFICE 35
313
152 SF
OFFICE 36
315
153 SF
STORAGE
317A
OFFICE 33
309
OFFICE 34
311
152 SF
STORAGE
313A
CORRIDOR
OFFICE 32
307
152 SF
OFFICE 31
305
152 SF
STORAGE
309A
BENCH
BENCH
OFFICE 30
303
153 SF
ELEC
OFFICE 18
326
152 SF
OFFICE 17
328
150 SF
OFFICE 19
324
152 SF
OFFICE 20
322
152 SF
OFFICES 21
320
152 SF
OFFICE 22
318
153 SF
OFFICE 23
CONFERENCE ROOM
24'-11 5/8"

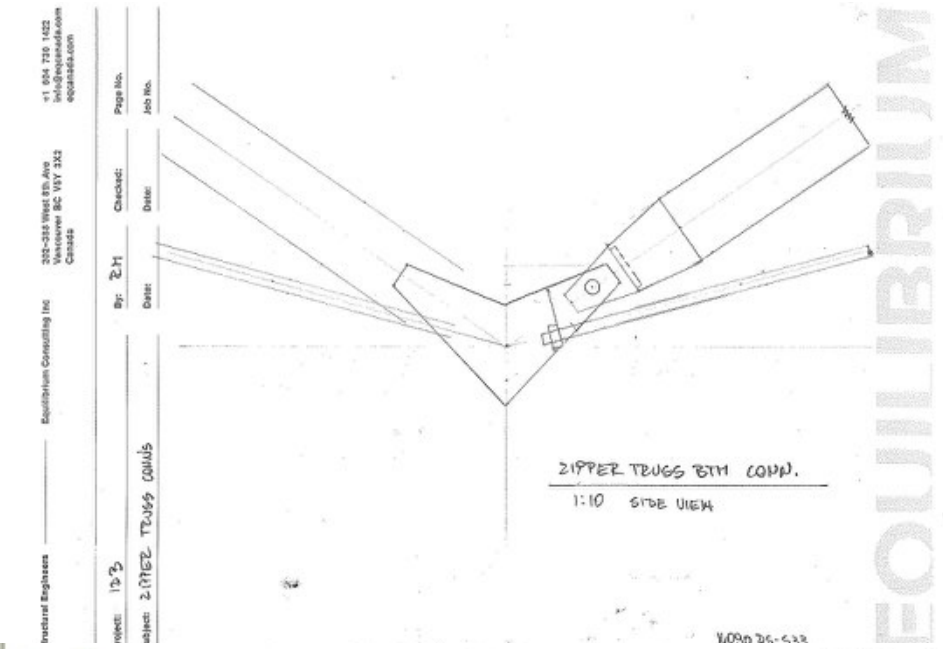

glass
glass
glass
Variations on the reverse pyramid geometry of zipper truss below.
but still has a non-symmetrical more dynamic form.
section

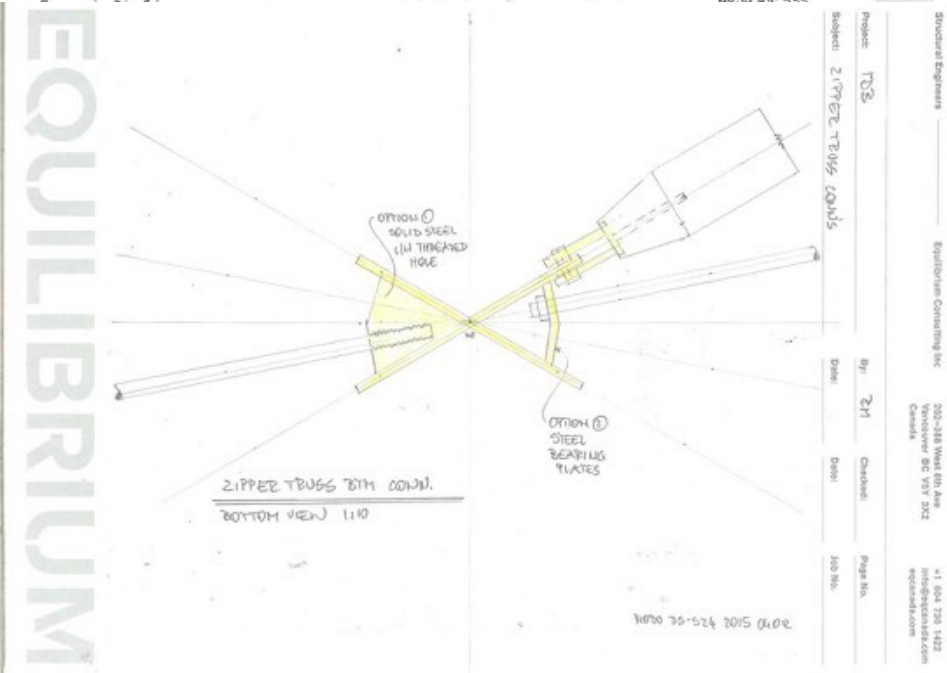
Courtyard Model Views

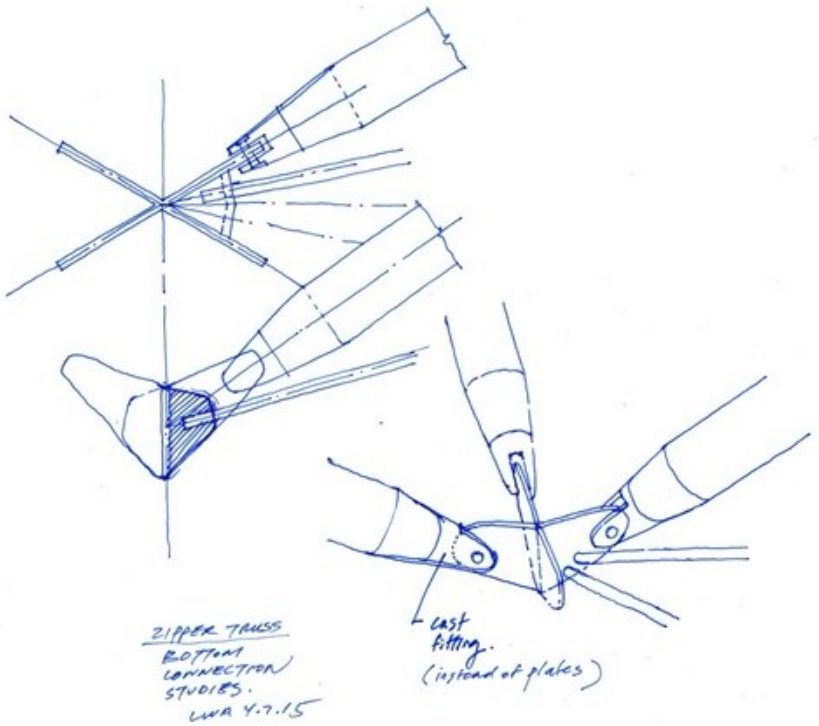
Zipper Truss Model



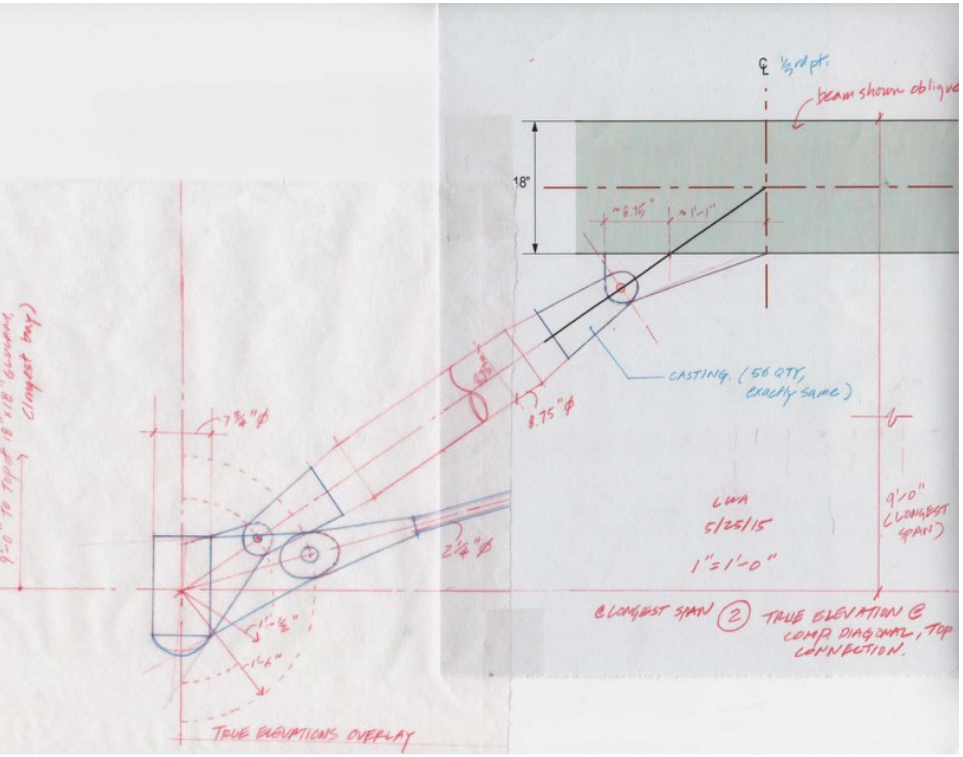
Central Connector Studies

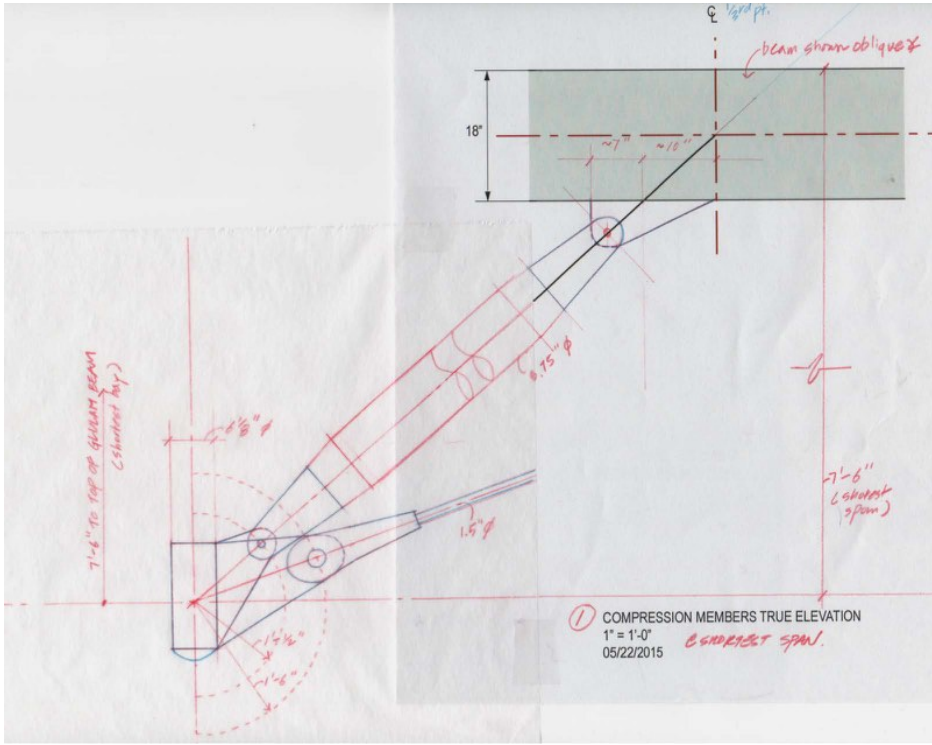




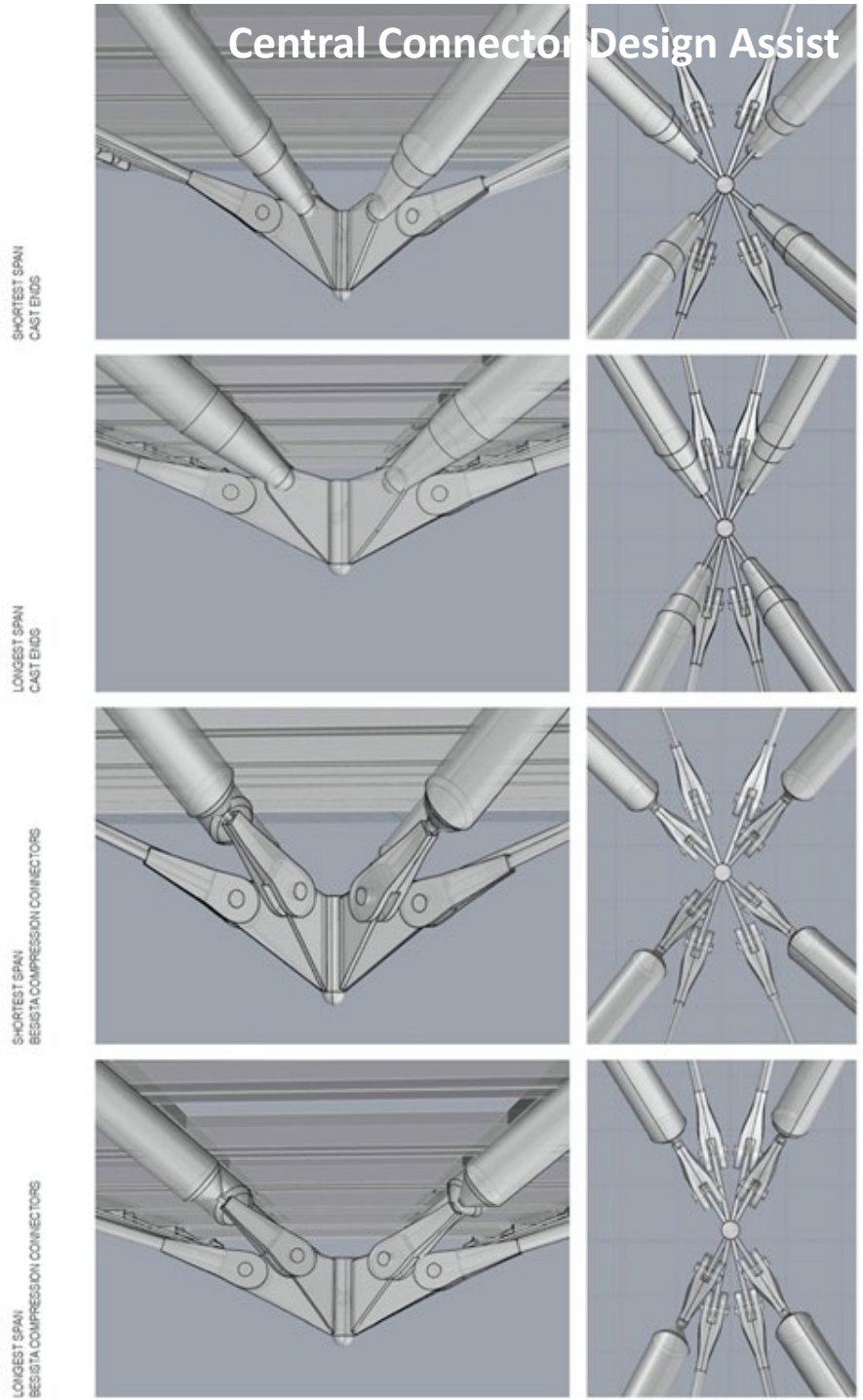


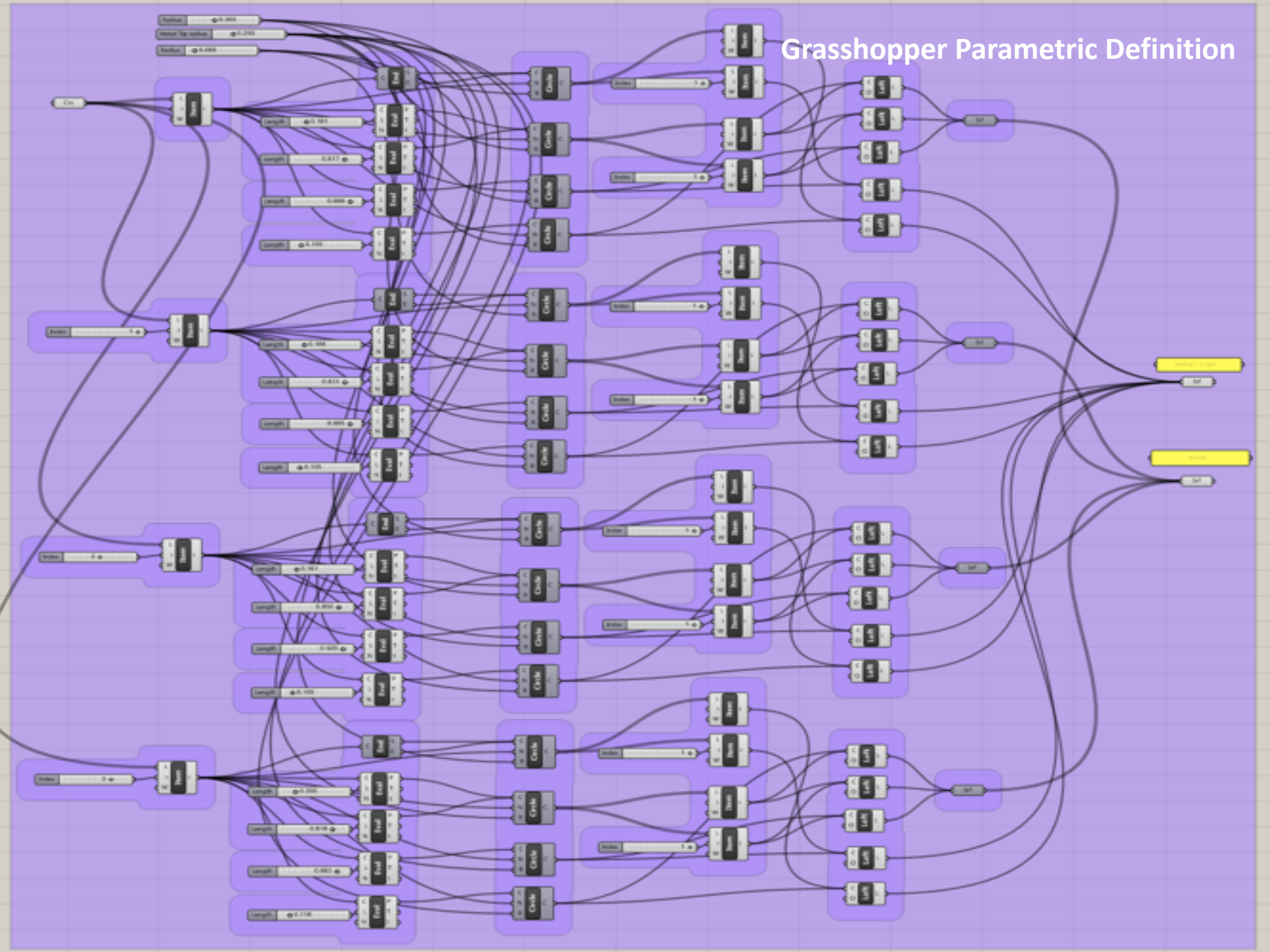
Central Connector Studies



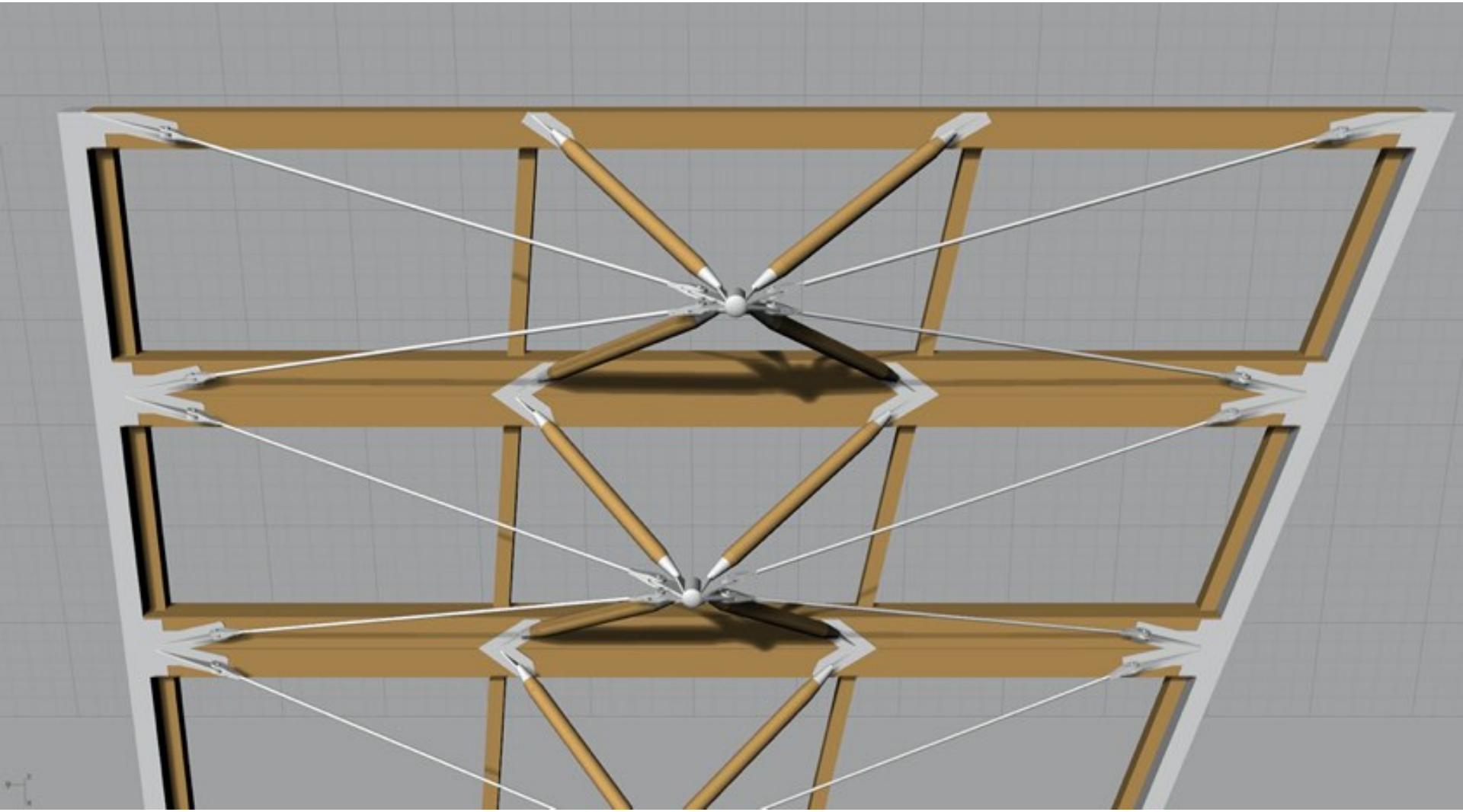


Central Connector Design Assist

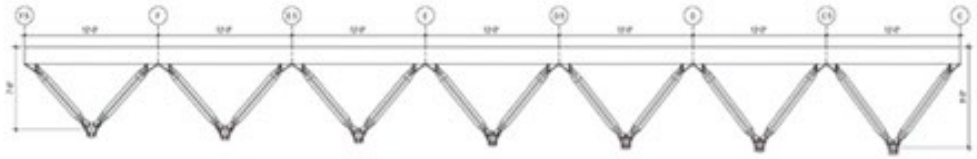



Grasshopper Parametric Definition

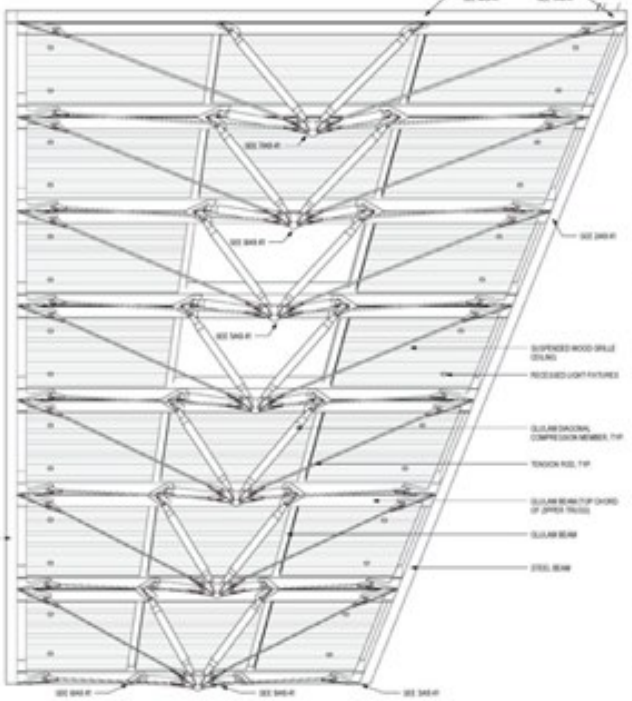
Rhino Model Detail



Profile and Layout



4 Zipper Truss_Elevation View From North, Looking South



3 Zipper Truss_General View From Below (Zipper Truss & Suspended Wood Grille Ceiling Shown Only)

2 Zipper Truss_Elevation View From East, Looking West

1 Zipper Truss_Elevation View From West, Looking East

GENERAL NOTES:

1. MODEL VIEWS SHOWN ARE INTENDED TO GIVE A GENERAL TASED DIMENSIONAL VISUAL REPRESENTATION OF ZIPPER TRUSS & ITS COMPONENTS ONLY. REFER TO STRUCTURAL DRAWINGS S7.00, S7.01, AND S7.02 FOR DIMENSIONS AND REQUIRED INFORMATION
2. REFER TO A2.00 FOR ROOF OF ZIPPER TRUSS AREA FOR COORDINATION W/ MEP/FP UTILITIES

UMASS DESIGN BUILDING

UNIVERSITY OF MASSACHUSETTS AMHERST, MA

UMBA PROJECT #12-A2
UMASS BUILDING #726

GMP BID DOCUMENTS

1 JUNE 2015

ZIPPER TRUSS VIEWS

A9.40

6/3/2015 5:11:12 PM

Process: Assuring the Client

Project Team and Stakeholders

Project Team

- **Client: University of Massachusetts Building Authority**

- **User: University of Massachusetts, Amherst**

Architecture & Design, LARP, Building Construction & Technology

- **Architectural / Structural Design Team:**
  - **Architect: Leers Weinzapfel Associates**
  - **Structural Design Engineer: Equilibrium Consulting**
  - **SER: SGH**

- **AHJ:**
  - **MA State Building Inspector**
  - **MA Board of Appeals**

- **Construction Team:**
  - **Construction Manager**
  - **Timber Fabricator and Installer**

Key Issues

- Danger of “Over Estimating Contingency” by Construction Managers or Cost Estimators due to the “Unknown”

- Importance of multiple Bidders

- Coordination of Fabricator and Installer Team

Alternative Structural Systems

CLT roof/floor panels and shear walls

CLT floor panels and glulam beams with composite concrete

Process: Code Review & Variance

TESTING

Process: Code Review & Variance

Alternative Structural Systems

Proposed Alternate Structural Systems

Cross Laminated Timber (CLT) roof and floor decks and shear walls

- 20 + years in Europe, recent projects in Canada similar to IDB
- Recognized in 2015 International Building Code and 2015 National Design Specification for Wood
- ANSI/APA PRG -320: current material fabrication requirements and stress grades
- CLT Handbook US Edition : Guidelines for CLT design and construction published by FPI, FPL and APA
- Connections between CLT panels similar to traditional wood frame construction
- Employing high strength, ductile HSK connections as shear wall anchors

CLT floor decks and glued laminated timber beams with composite concrete deck

- 20 + years in Europe, extensive research and testing in Germany with HBV connector system
- CLT units provide required strength, concrete decks only counted on for stiffness

Process: Code Review & Variance

Concealed Ceiling Areas

5318 SF CONCEALED SPACE

23.8% OF FLOOR AREA HAS CONCEALED SPACE

THIRD FLOOR REFLECTED CEILING PLAN

A6.03

CONSTRUCTION

How is it Constructed?

Very Much like a Steel Building

Steel Post & Beam	⟹	Glulam Post & Beam
Steel/Concrete Floors	⟹	CLT/Concrete Floors
Steel Deck Roof	⟹	CLT Roof
Concrete Shafts	⟹	CLT Shafts
Steel Braces	⟹	Glulam Braces

Post and Beam Structural Framework

Post and Beam Structural Framework

Glulam Beam to Column Connection

Glulam Beam to Column Connection

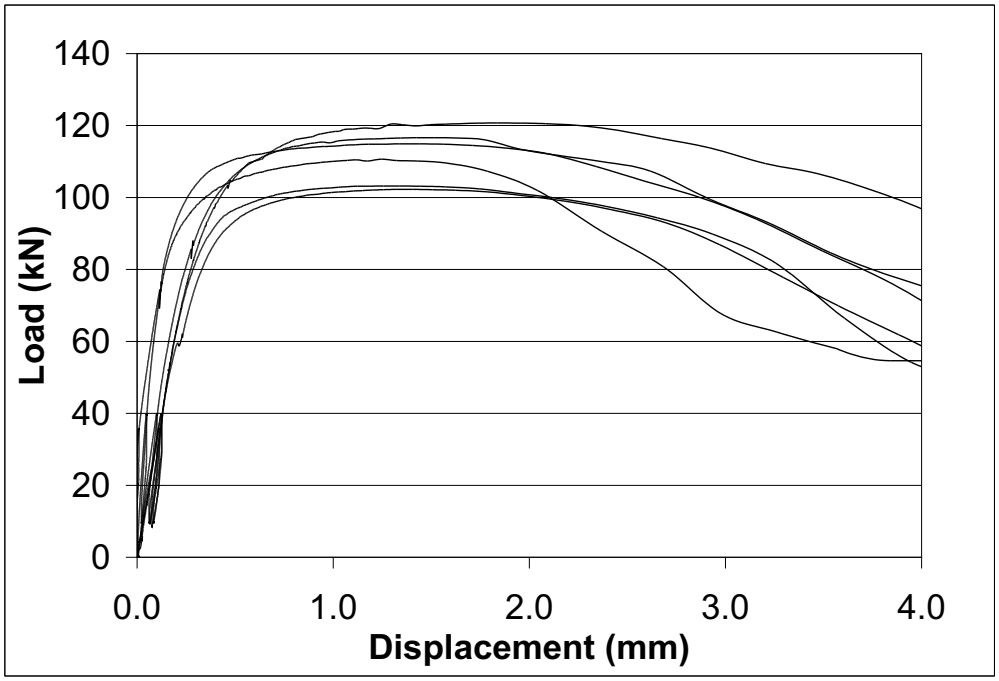

Steel-Concrete Composite

Steel – Concrete Composite

CLT – Concrete Composite

CLT – Concrete Composite

UMass research on HBV Shear Connector



- Clouston P, Bathon L, Schreyer A. 2005. "Shear and Bending Performance of a Novel Wood-Concrete Composite System". *ASCE Journal of Structural Engineering*. 131(9), pp.1404-1412

- Clouston P, Schreyer A. 2008. "Design and Use of Wood-Concrete Composites". *ASCE Practice Periodical on Structural Design and Construction*, 13(4), pp. 167-175

CLT - Concrete Composite Floor

CLT - Concrete Composite Floor

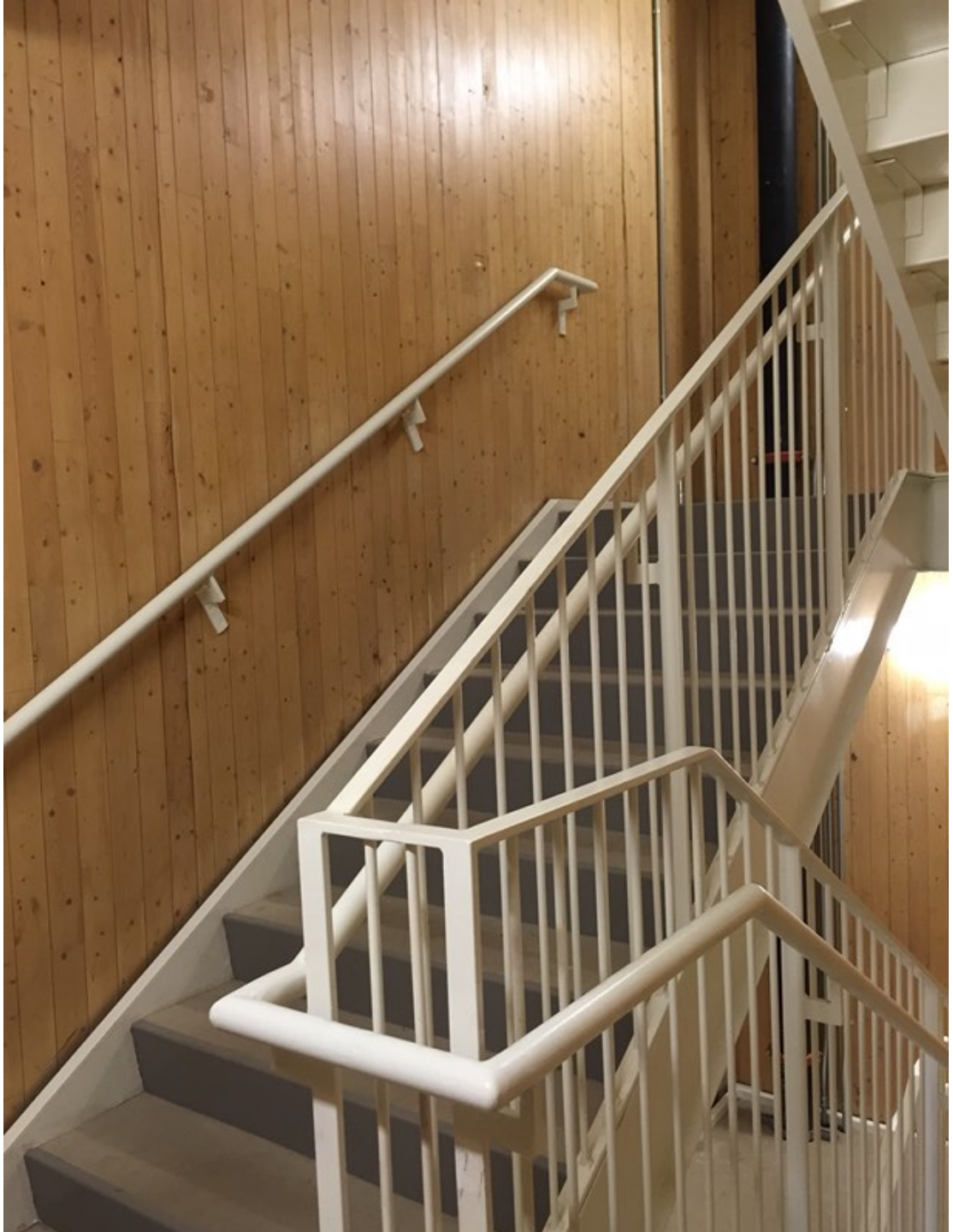
CLT - Concrete Composite Floor

CLT - Concrete Composite Floor

Concrete Shaft

CLT Shaft

Photo credit: A. Schreyer



Steel Bracing

Lateral Cross Bracing

Lateral Cross Bracing

Lateral Cross Bracing

Lateral Cross Bracing

Zipper truss mid-air assembly

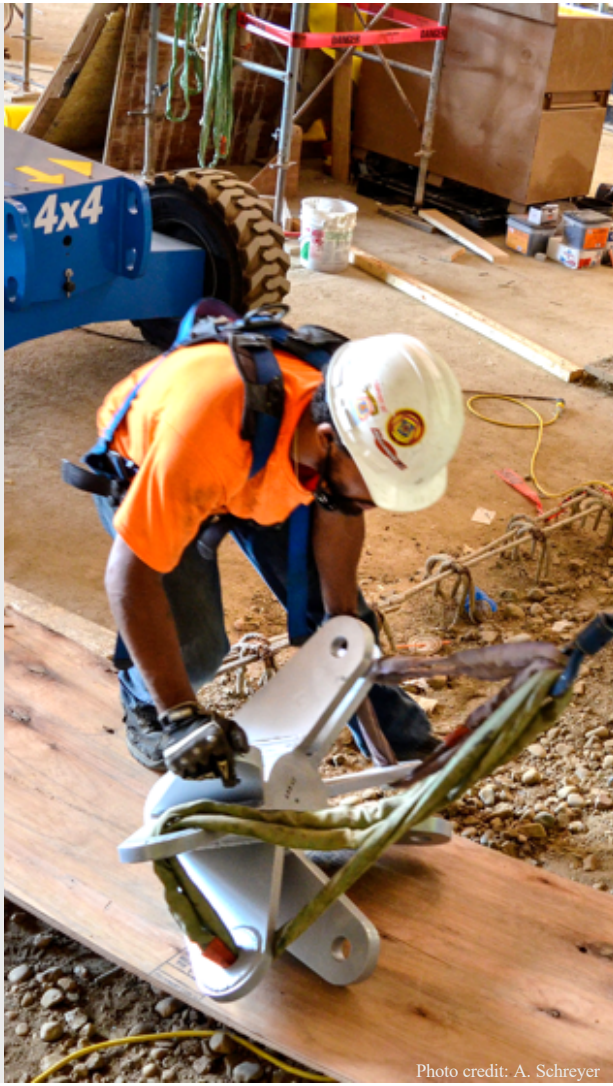
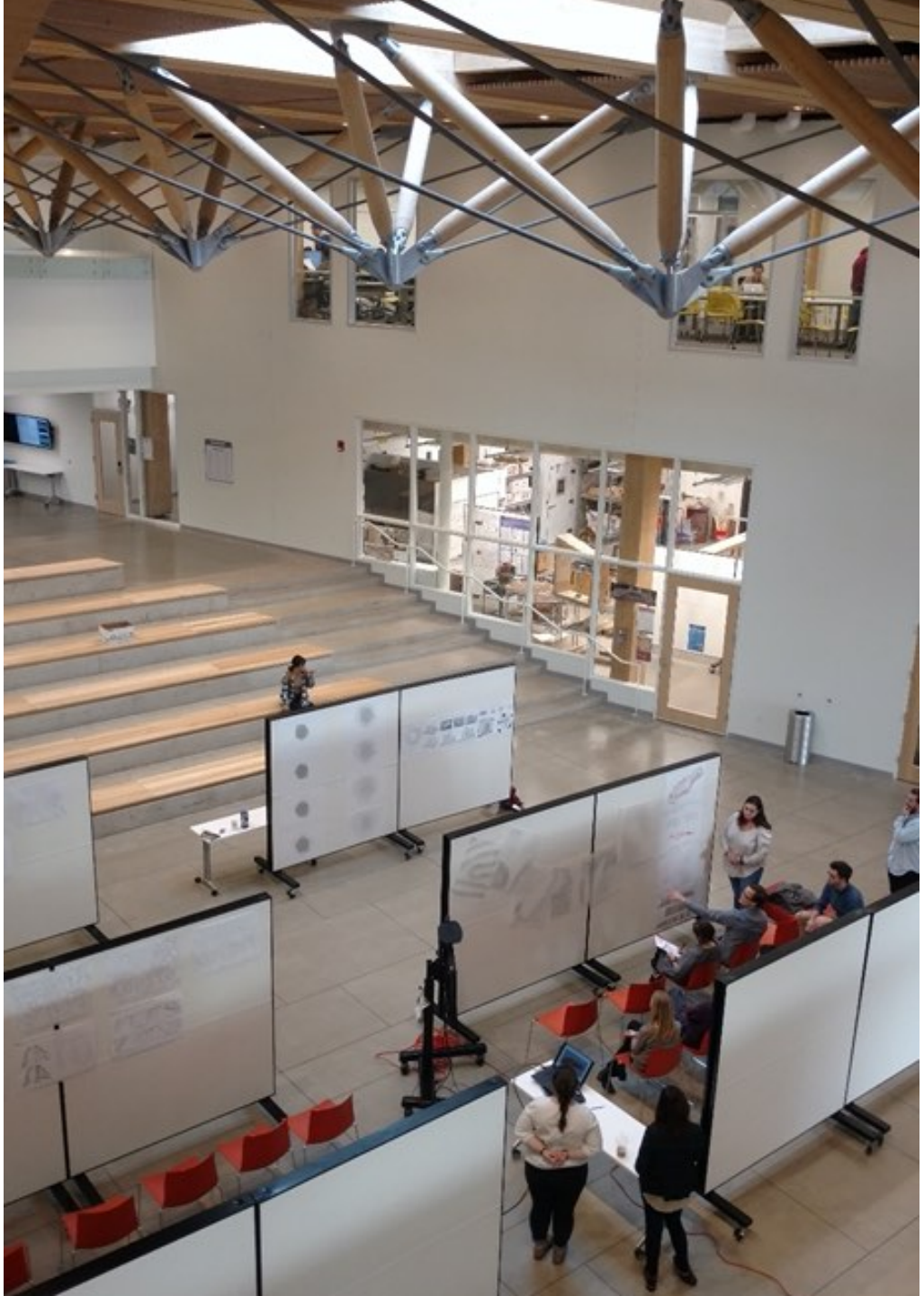


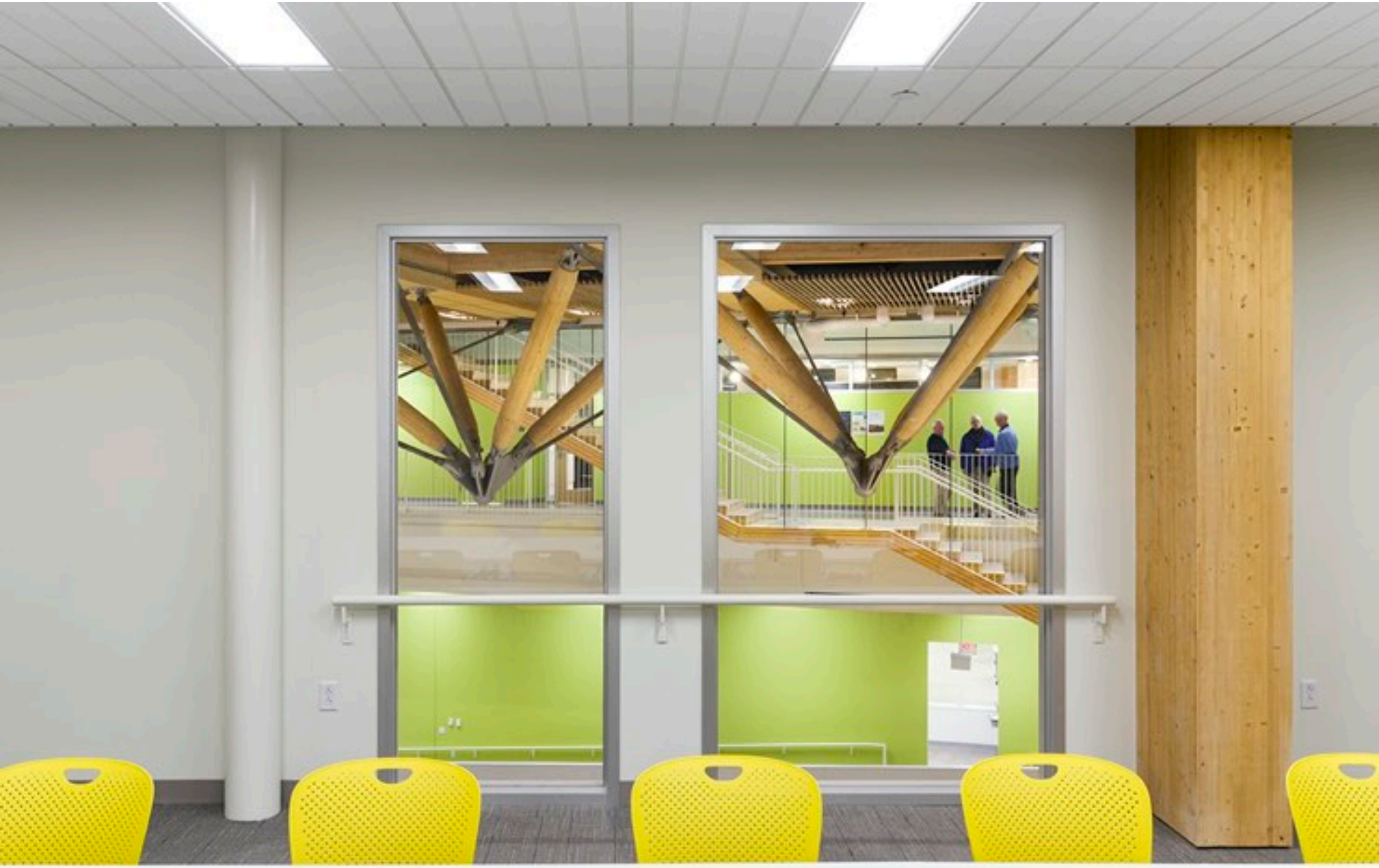
Photo credit: A. Schreyer

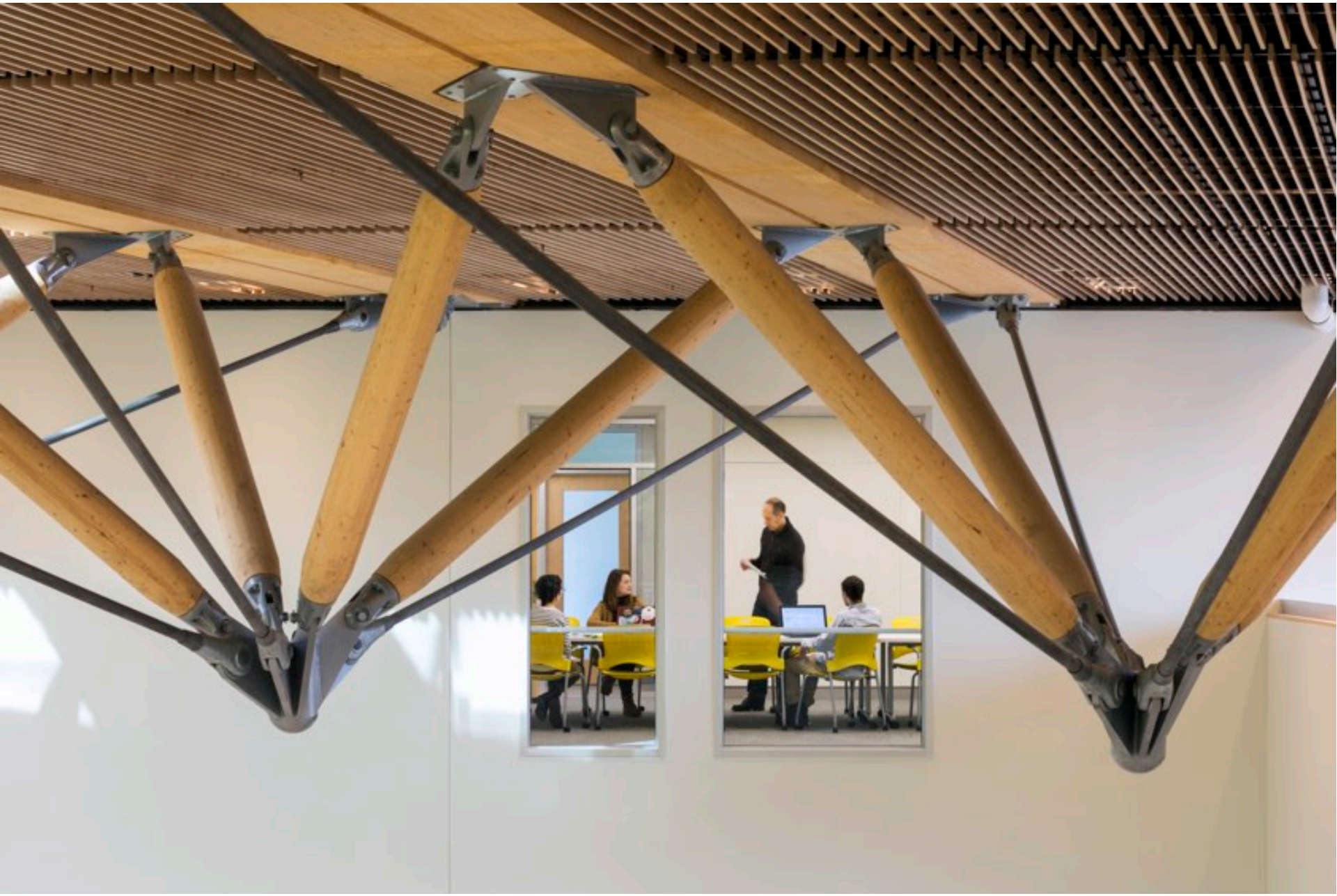

Photo credit: A. Schreyer


S-45

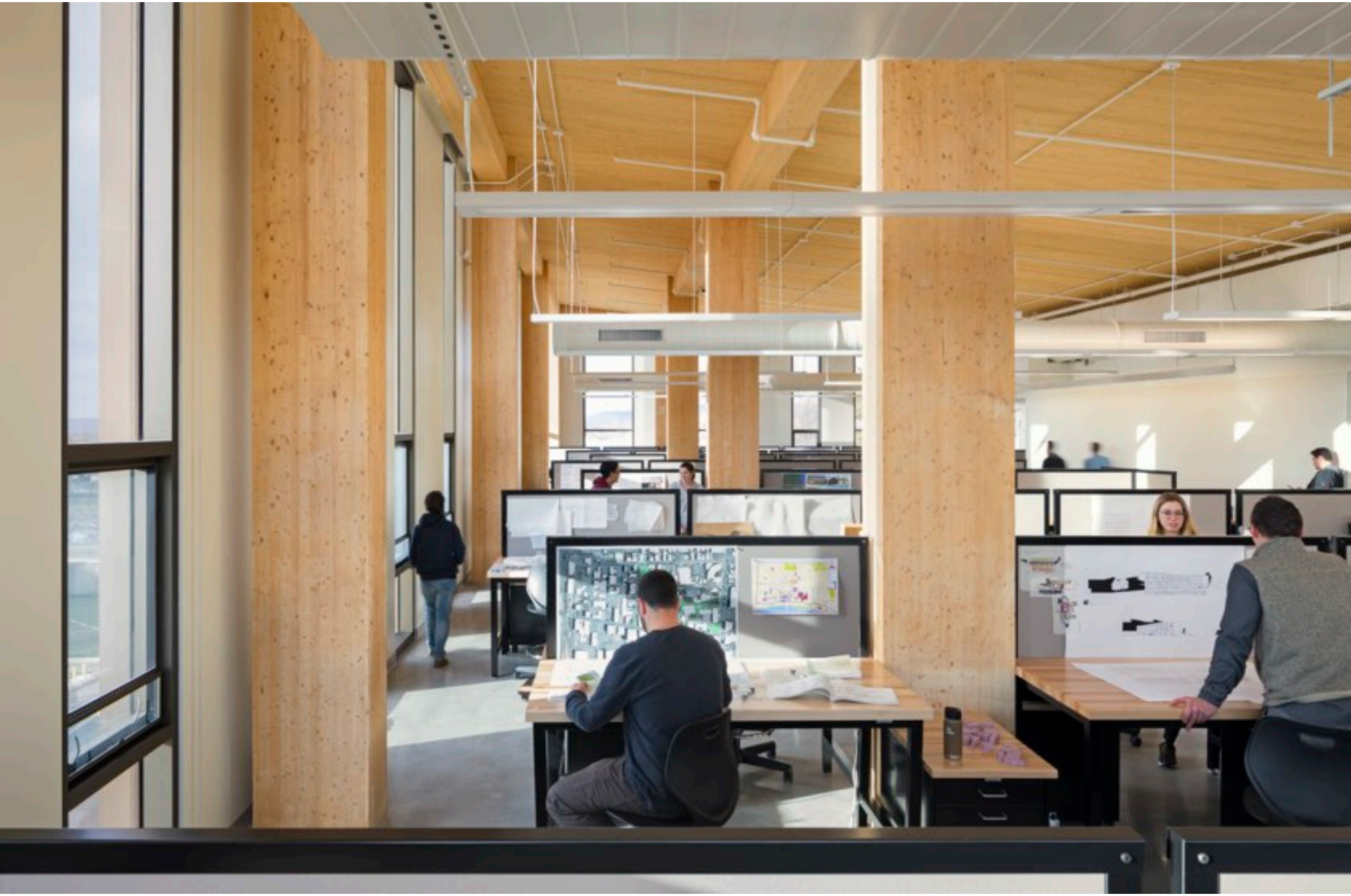
OCCUPANCY PHASE & BENEFITS







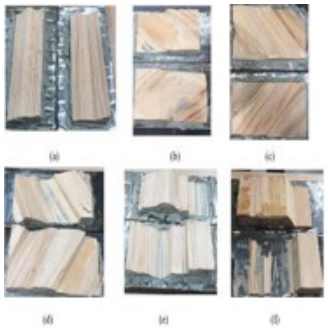
Conference rooms offer sweeping views of campus and opportunities for close-up views of the structural timber



Rooftop courtyard

Panel Manufacture

Experimental Testing and Evaluation



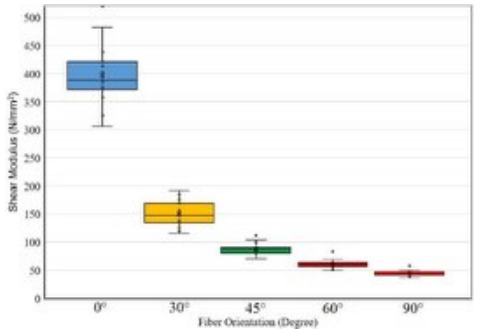


Table 8 4-point bending test results and analytical predictions

	Test Result					Analytical Prediction		
	Pmax (lb.)	Δ max (in)	$EI_{app}{}^{*}$ ($10^6 lb.in^2$/ft)	$f_b S_{eff}$ (lb.ft/ft)	$f_s(lb/Q)_{eff}$ (lb/ft)	Pmax (lb.)	Δ max (in)	EI_{eff} ($10^6 lb.in^2$/ft)
EH-CLT-1	14,118	3.94	95.05	17,068	4,642	15,659	5.60	95.68
EH-CLT-2	13,705	5.62	84.79	18,897	5,139	13,587	5.64	99.86
EH-CLT-3	13,247	4.11	91.73	17,652	4,996	13,514	5.62	99.07
Mean	----	----	90.52	17,872	4,926	----	----	98.20
COV (%)	----	----	5.78	5.23	5.19	----	----	2.26
Characteristic Value	----	----	90.52	17,126	4,677	----	----	98.20

$* EI_{app} = \frac{Pa(3L^2 - 4a^2)}{48\Delta}$

Carbon Summary

Volume of wood products used (m^3):
2081 m^3 (73482 ft^3) of lumber and sheathing

U.S. and Canadians forests grow this much wood in:
6 minutes

Carbon stored in the wood:
1463 metric tons of CO_2

Avoided greenhouse gas emissions:
1218 metric tons of CO_2

Total potential carbon benefit:
2681 metric tons of CO_2

Equivalent to:

512 cars off the road for a year

Energy to operate a home for **228** years

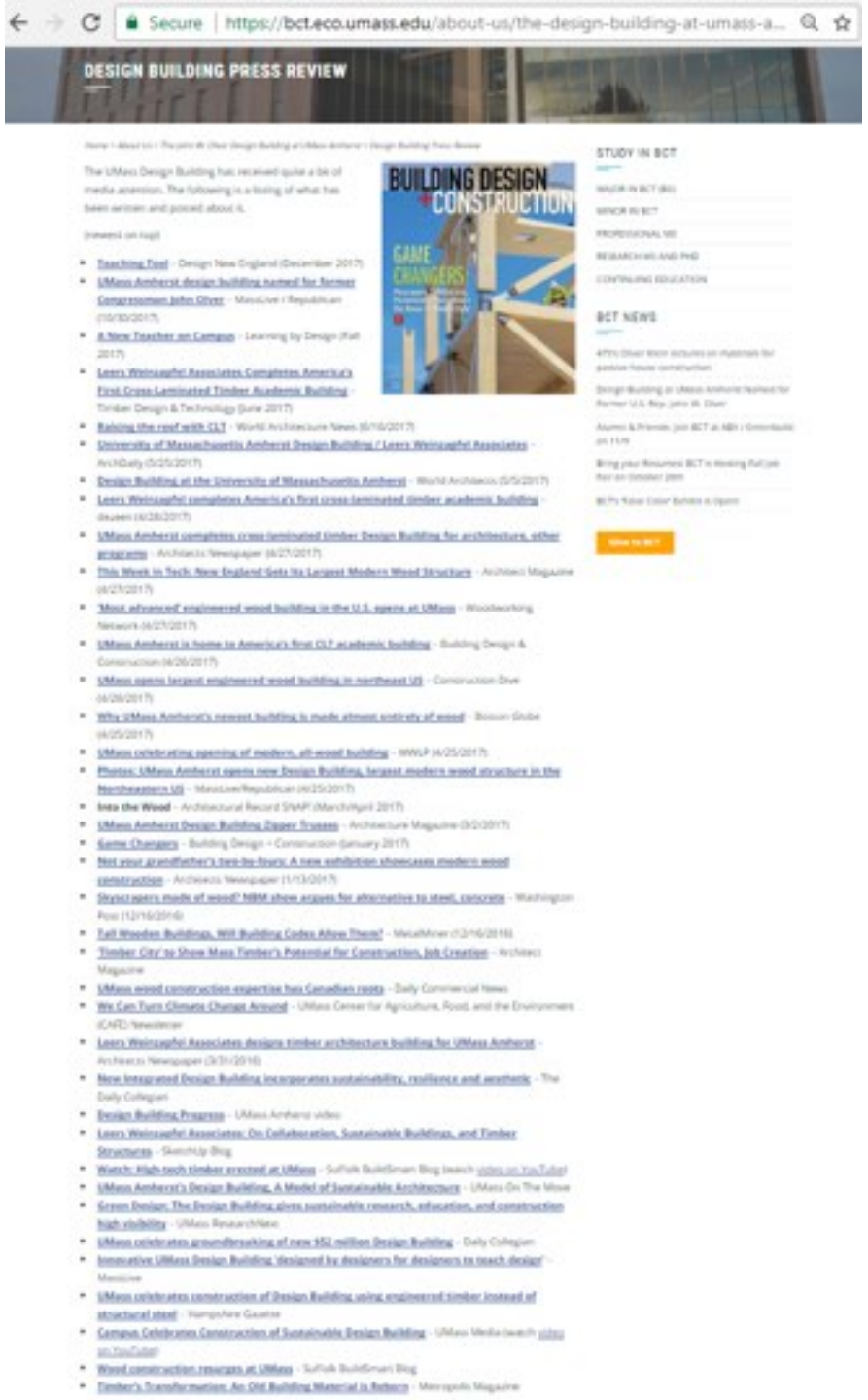
reTHINK WOOD

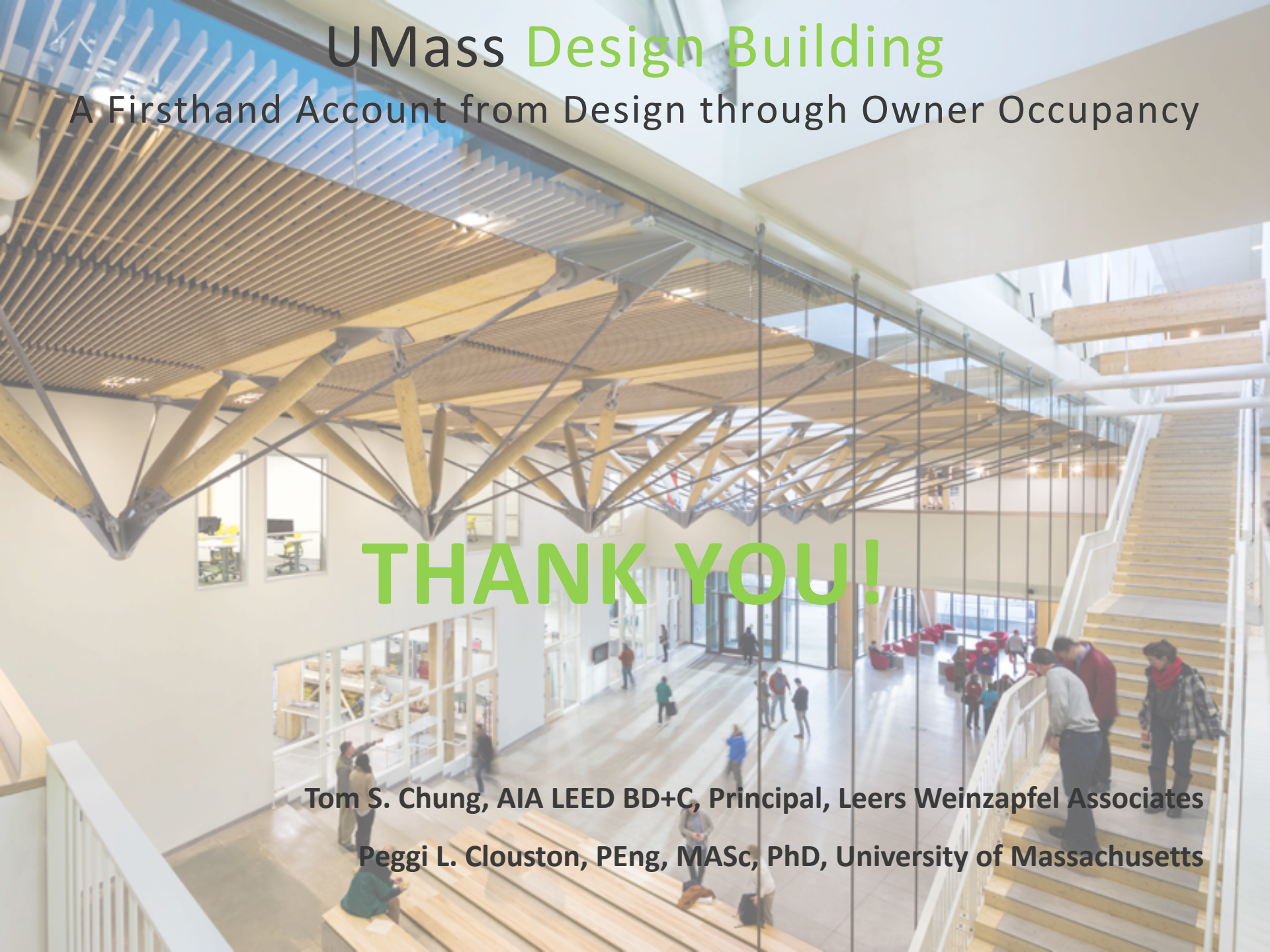
Awards

- 2018 **Wood Design Awards Jury's Choice for Wood Innovation**, WoodWorks
- 2017 **Building of the Year**, world-architects
- 2017 **Most Innovative Project Award** (less than $100 million), Architectural Engineering Institute
- 2017 **Excellence in Structural Engineering Award** (New Buildings $20 to $100 Million), National Council of Structural Engineering Associations
- 2017 **Awards of Merit for Structural Systems Design and Architectural Engineering Integratio**n, Architectural Engineering Institute
- 2017 **Award of Merit, Higher Education/Research Category**, ENR New England
- **+ 6 more!**

Read all about it

https://bct.eco.umass.edu/about-us/the-design-building-at-umass-amherst/design-building-press-review/





UMass Design Building

A Firsthand Account from Design through Owner Occupancy

THANK YOU!

Tom S. Chung, AIA LEED BD+C, Principal, Leers Weinzapfel Associates

Peggi L. Clouston, PEng, MASc, PhD, University of Massachusetts

QUESTIONS?

This concludes The American Institute of Architects Continuing Education Systems Course

Tom S. Chung, AIA LEED BD+C, Principal, Leers Weinzapfel Associates

Peggi L. Clouston, PEng, MASc, PhD, University of Massachusetts