
Local Church of the Saints
CY Lee Architect

Jackson Triggs Winery, KPMB

U of T Academic Tower
Patkau/MJMA


George Brown “the Arbour”
Patkau/MJMA


77 Wade Avenue
BNC Architects


French River Visitors Centre
BSN Architects

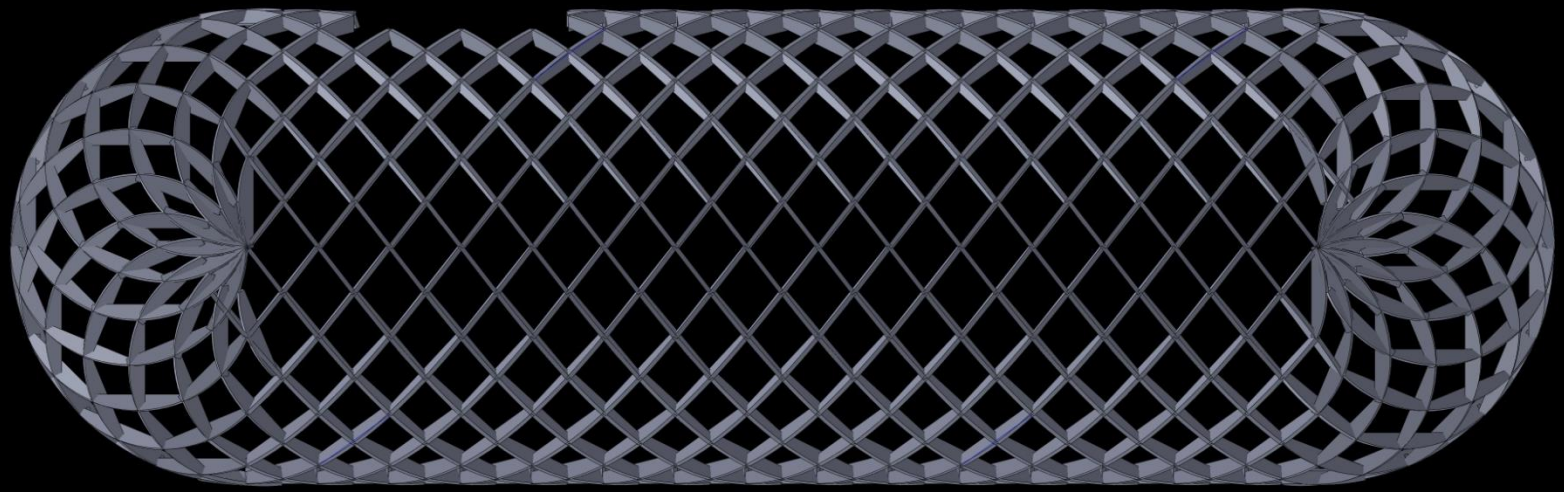
Moorelands Camp Dining Hall, Shim Sutcliffe

Blackwell

fæt lab

Forum Wood Building Nordic 2019

Reciprocal Framing Systems

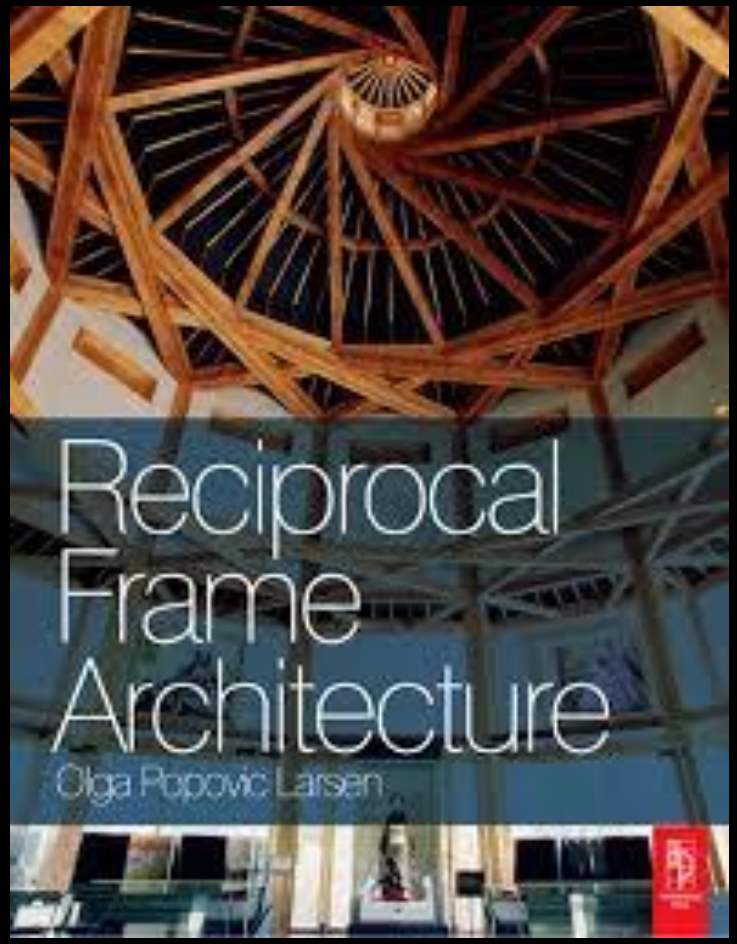


David Bowick, P.Eng.
Shannon Hilchie, P.Eng.

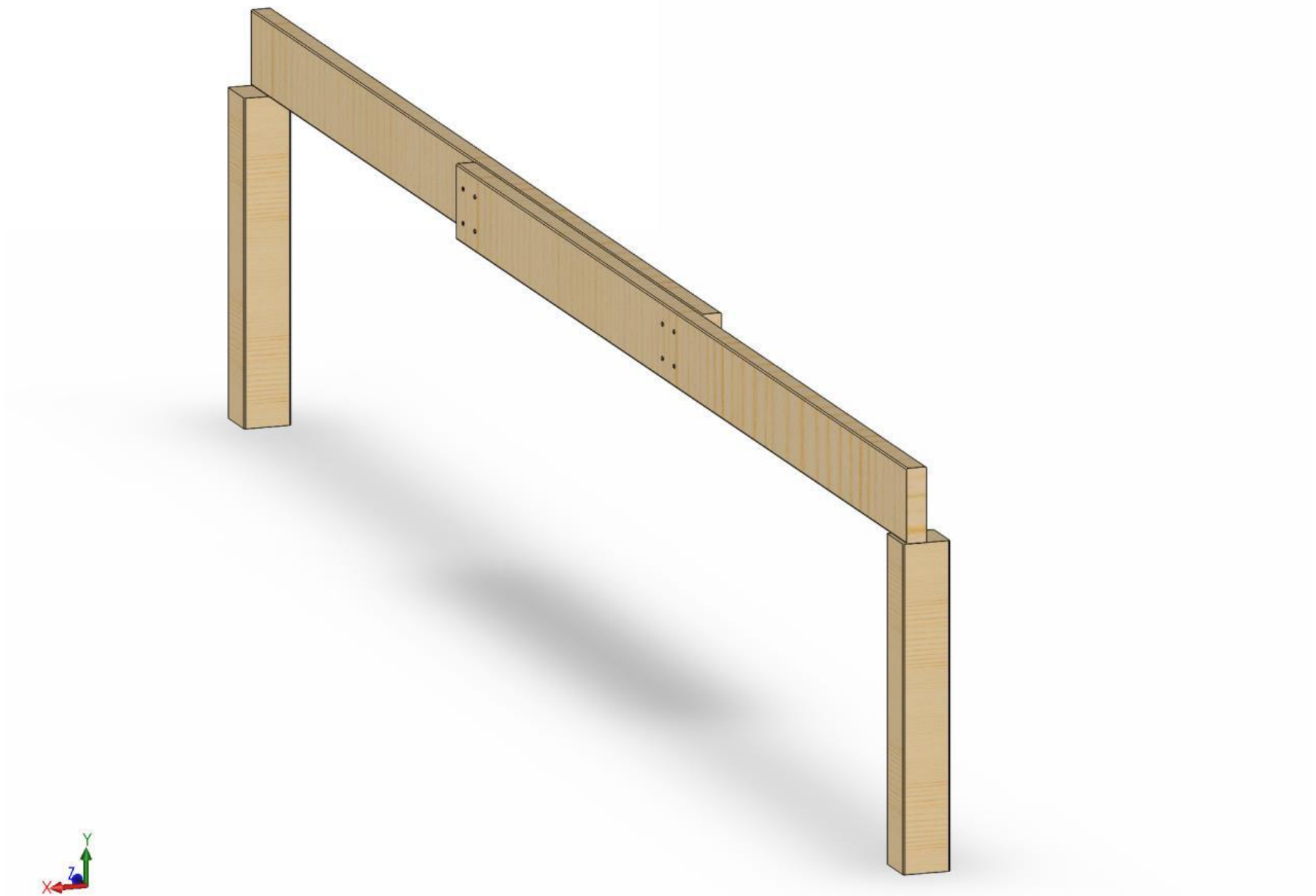
25 September 2019

WHAT

Reciprocal Frame - “A structure made up of mutually supporting beams in a closed circuit”

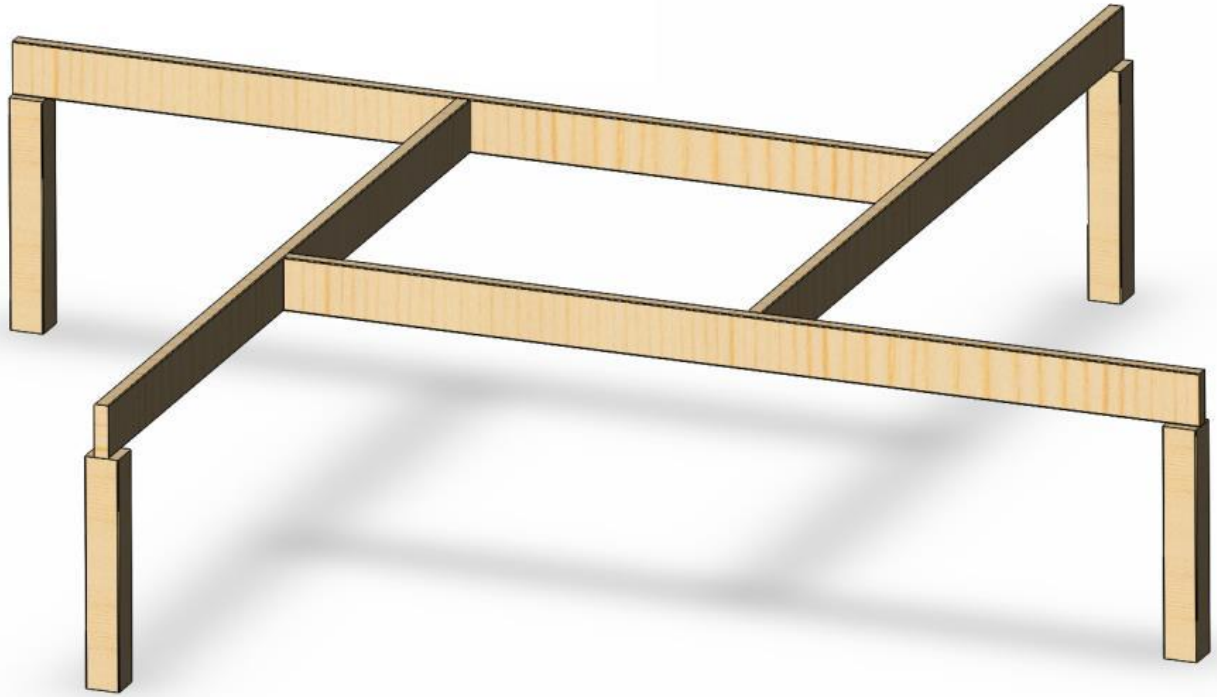


Reciprocal Frame Architecture
Olga Popovic Larsen, 2008


Y
Z
X

100% of 1 Beam

100% of 1 Beam



100% of 1 Beam

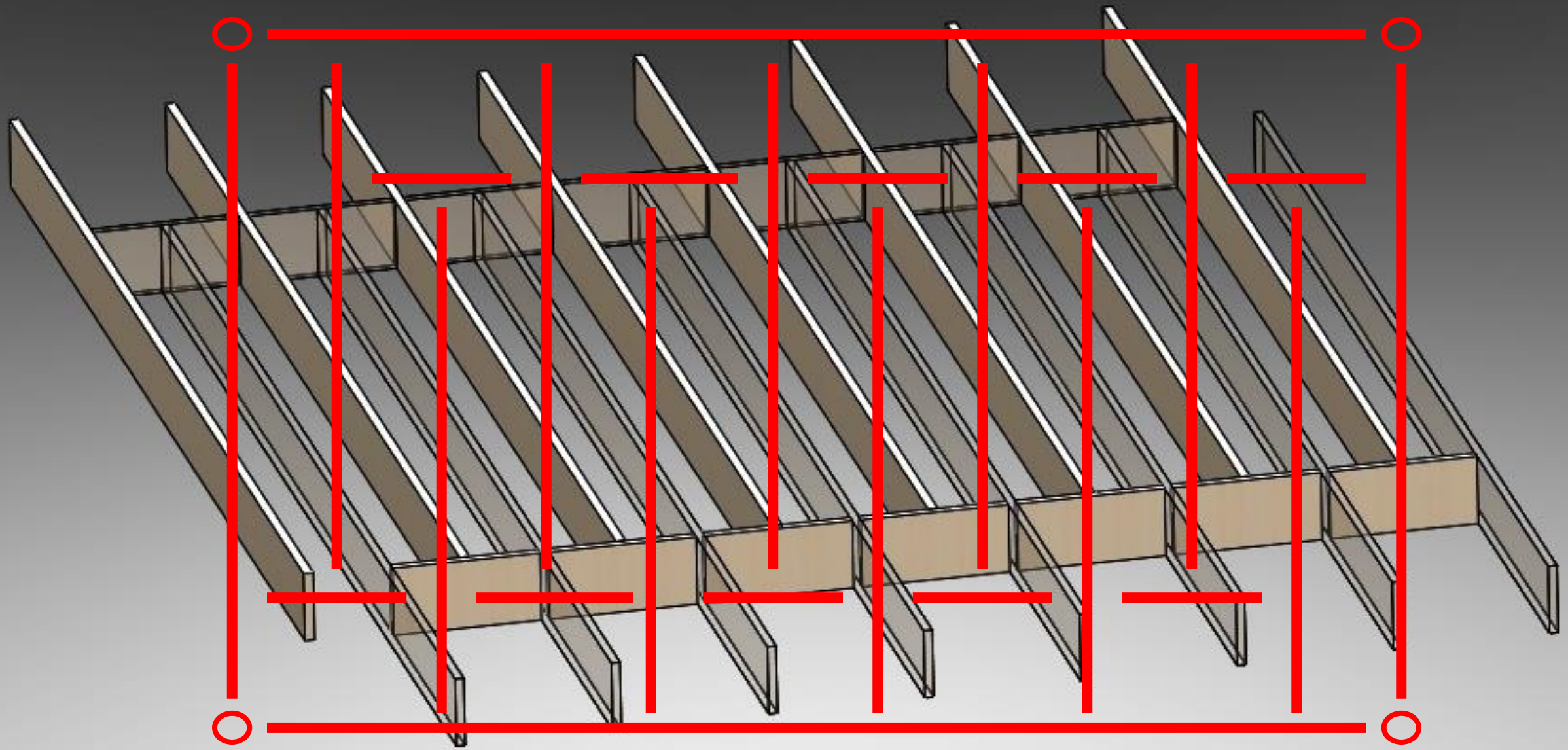
100% of 1 Beam

WAY

- Span
- Geometric Complexity
- 2-Way Action
- Folly

SPAN

How do you use a 5m joist to span 6m?



FOLLY

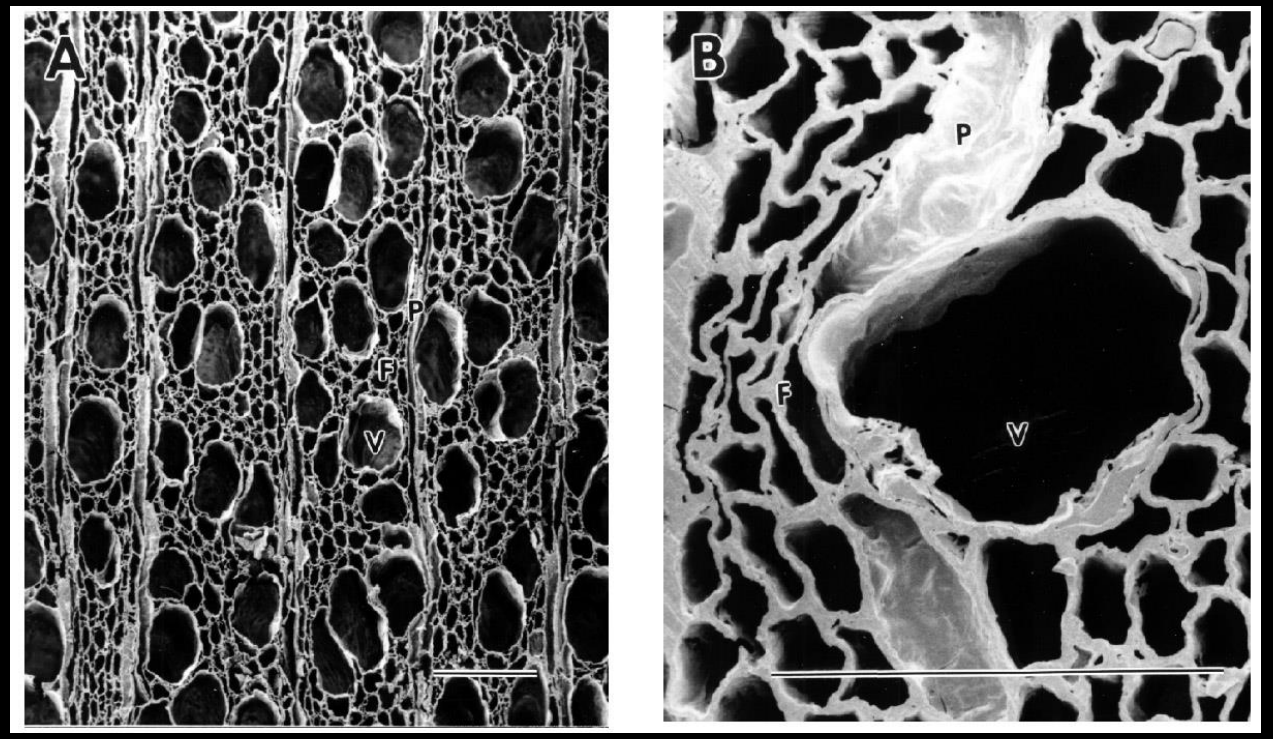
When a problem is redefined to suit a preferred solution.

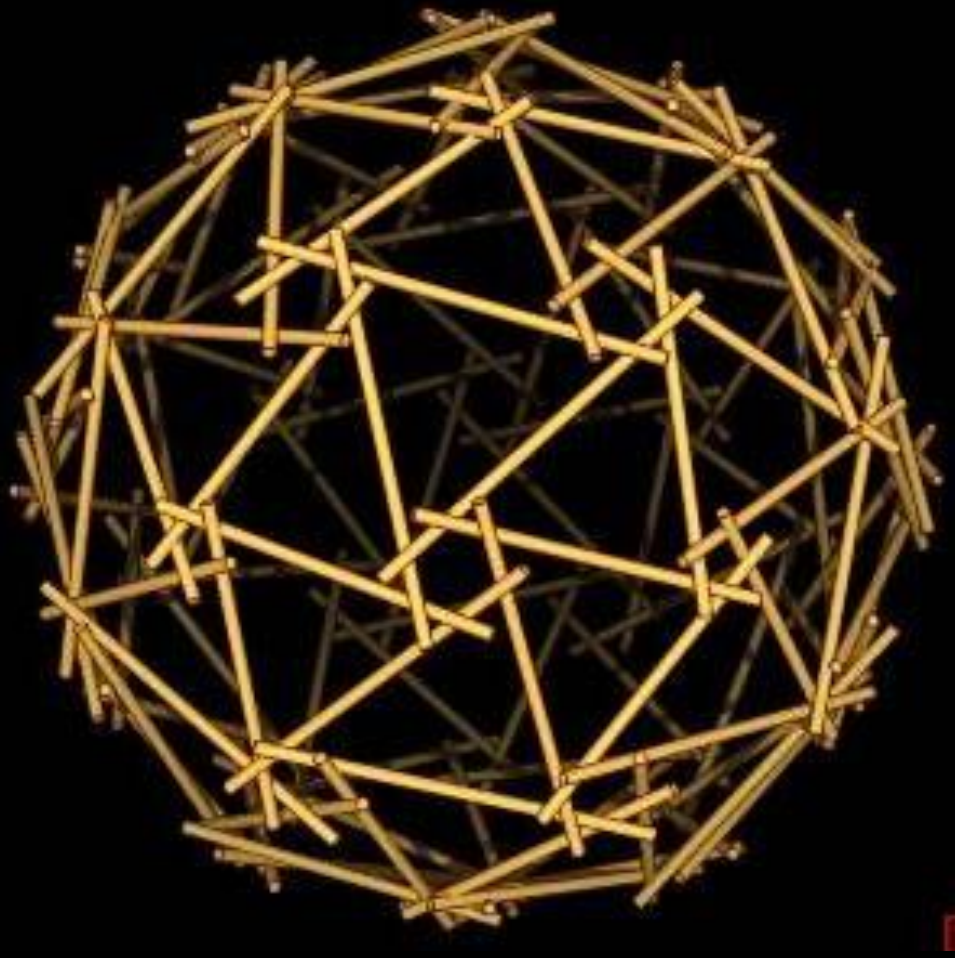

Image from minktoast.net

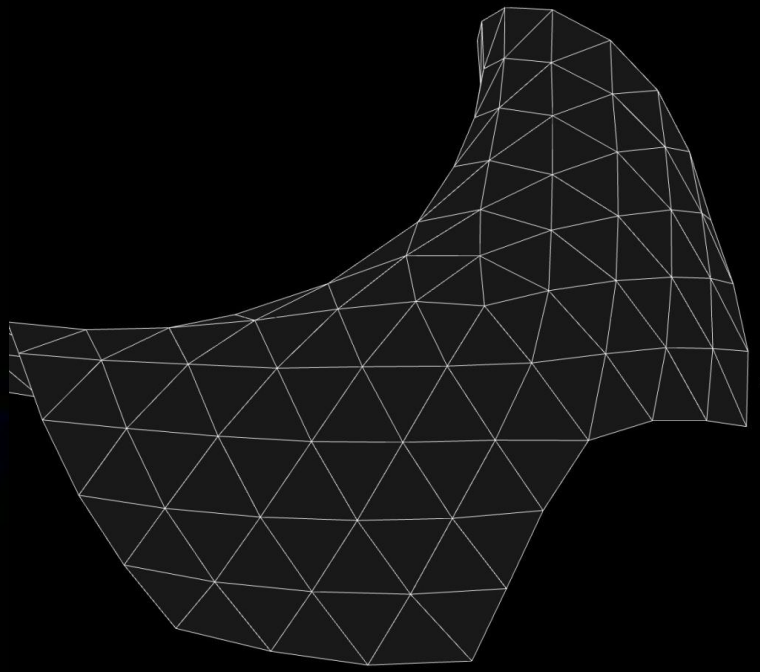
COMPLEXITY

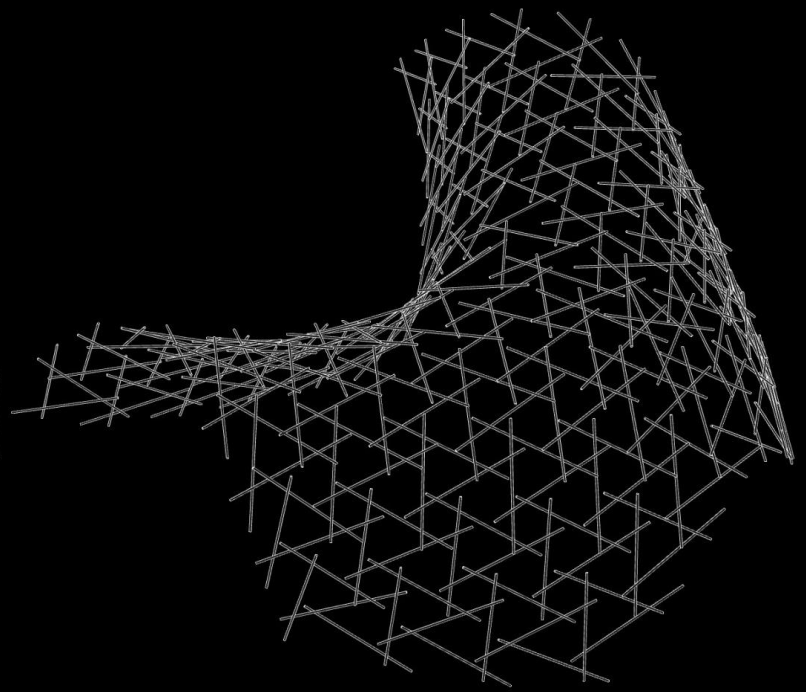
Lamella -
“A thin scale, plate, or layer of bone or tissue…”

- The American Heritage® Dictionary of the English Language

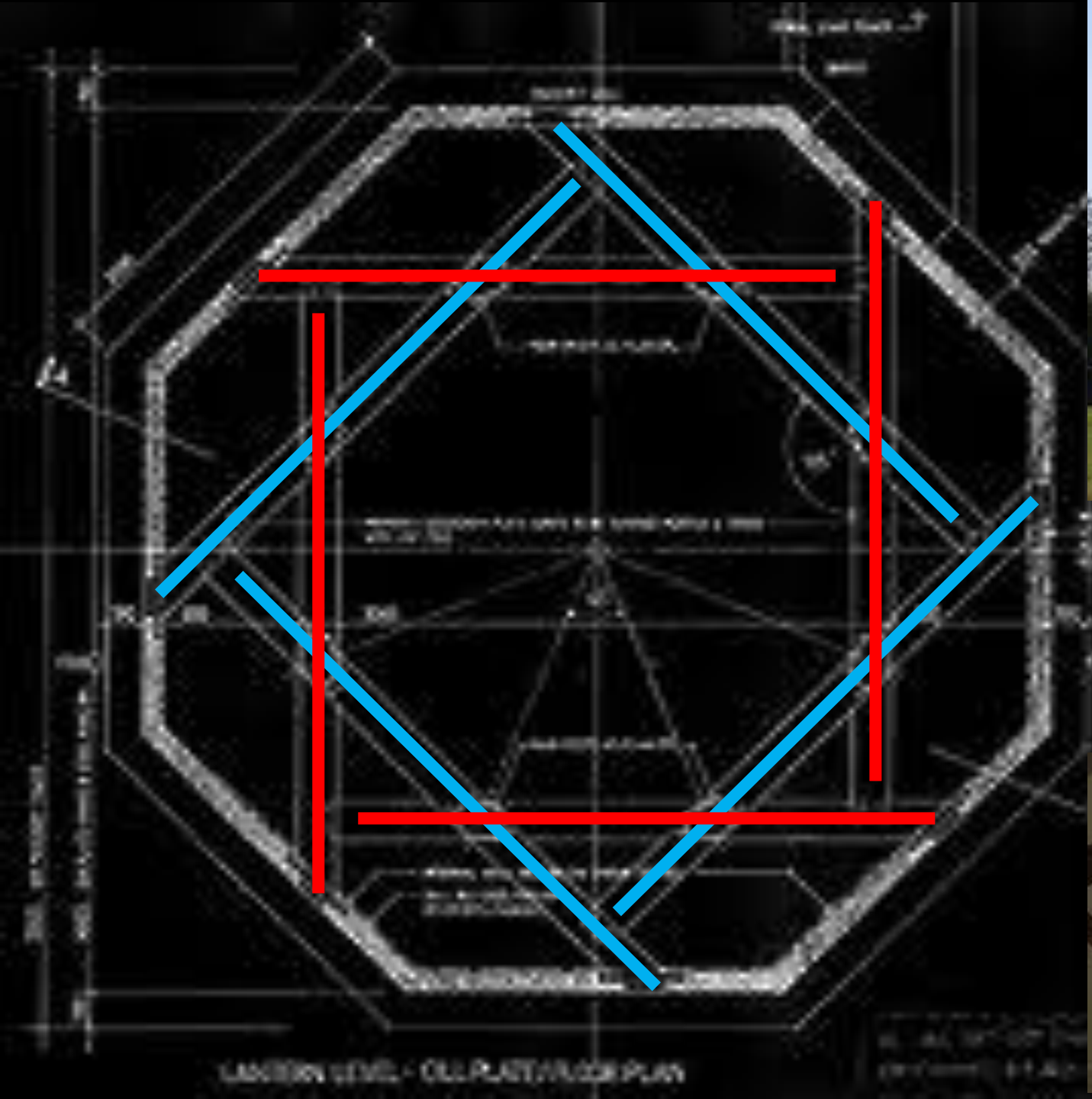








http://www.grasshopper3d.com/



2-WAY

HISTORY

1270 - Present

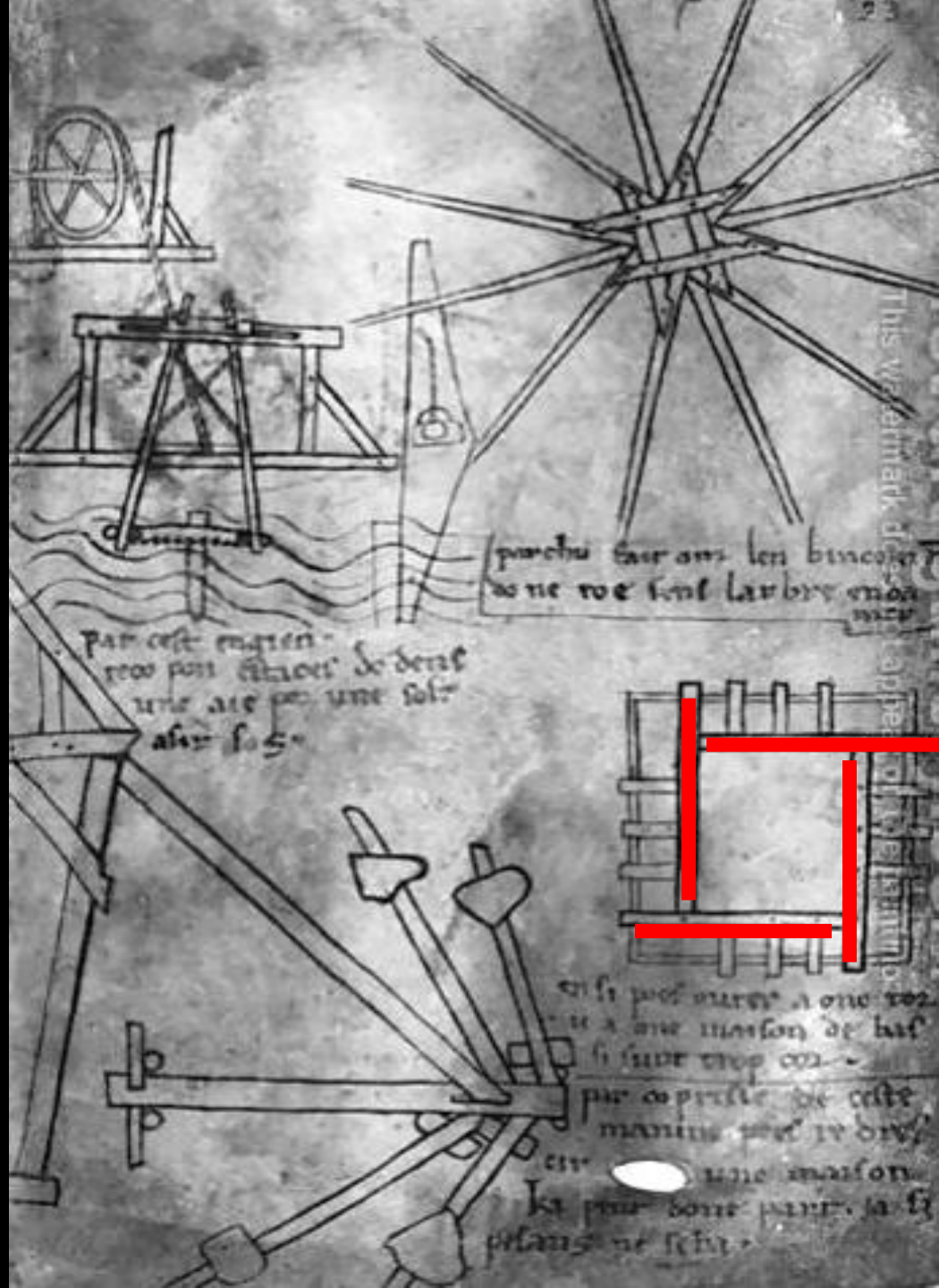
Villard de Honnecourt

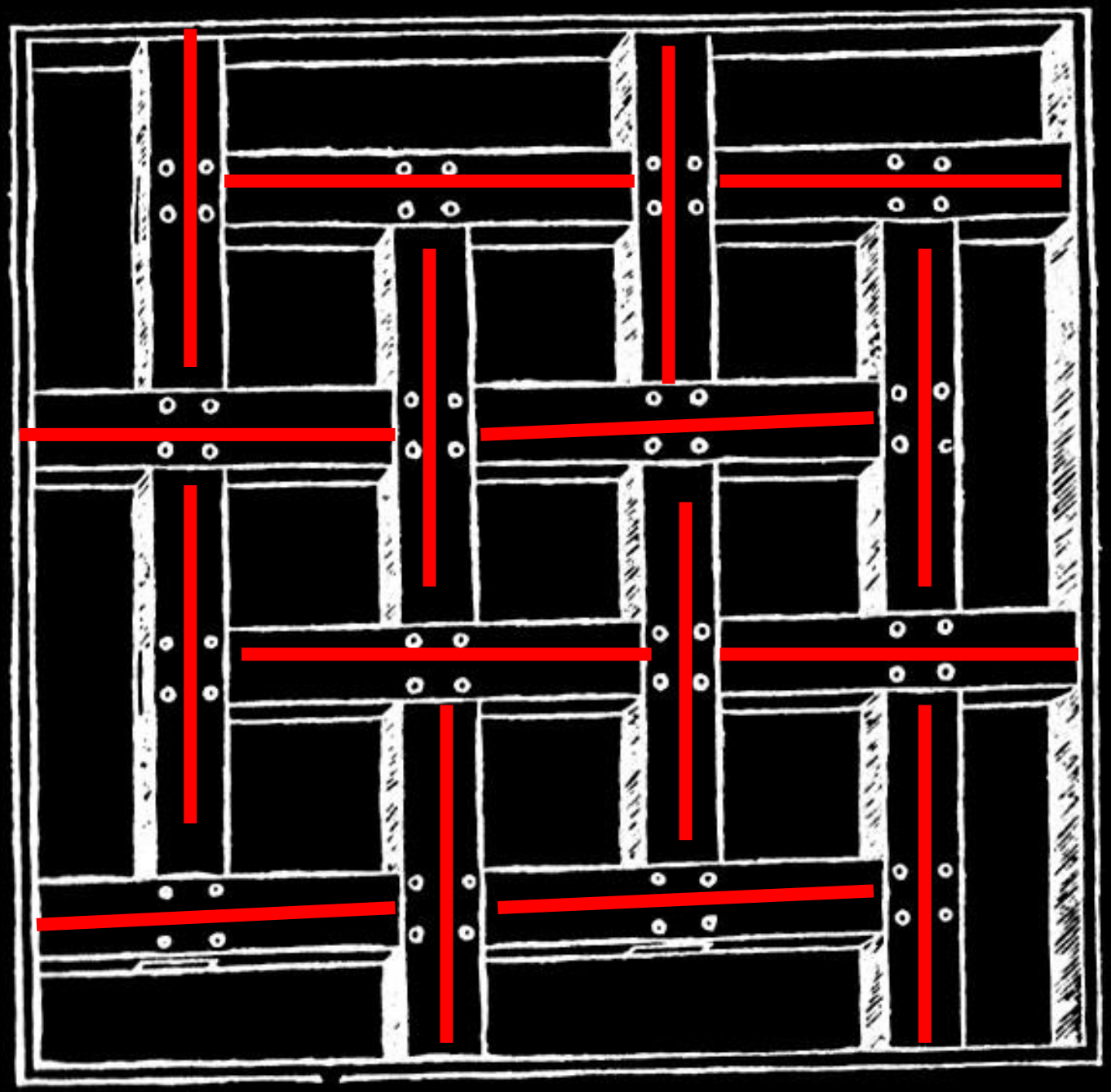
Reciprocal frame Sketches

1270

"ensi poes ovrer a one tor u a one maison de bas si sunt trop cor"

"how to work with a tower or with a house using timbers that are too short"





Sebastiano Serlio 1475-1554

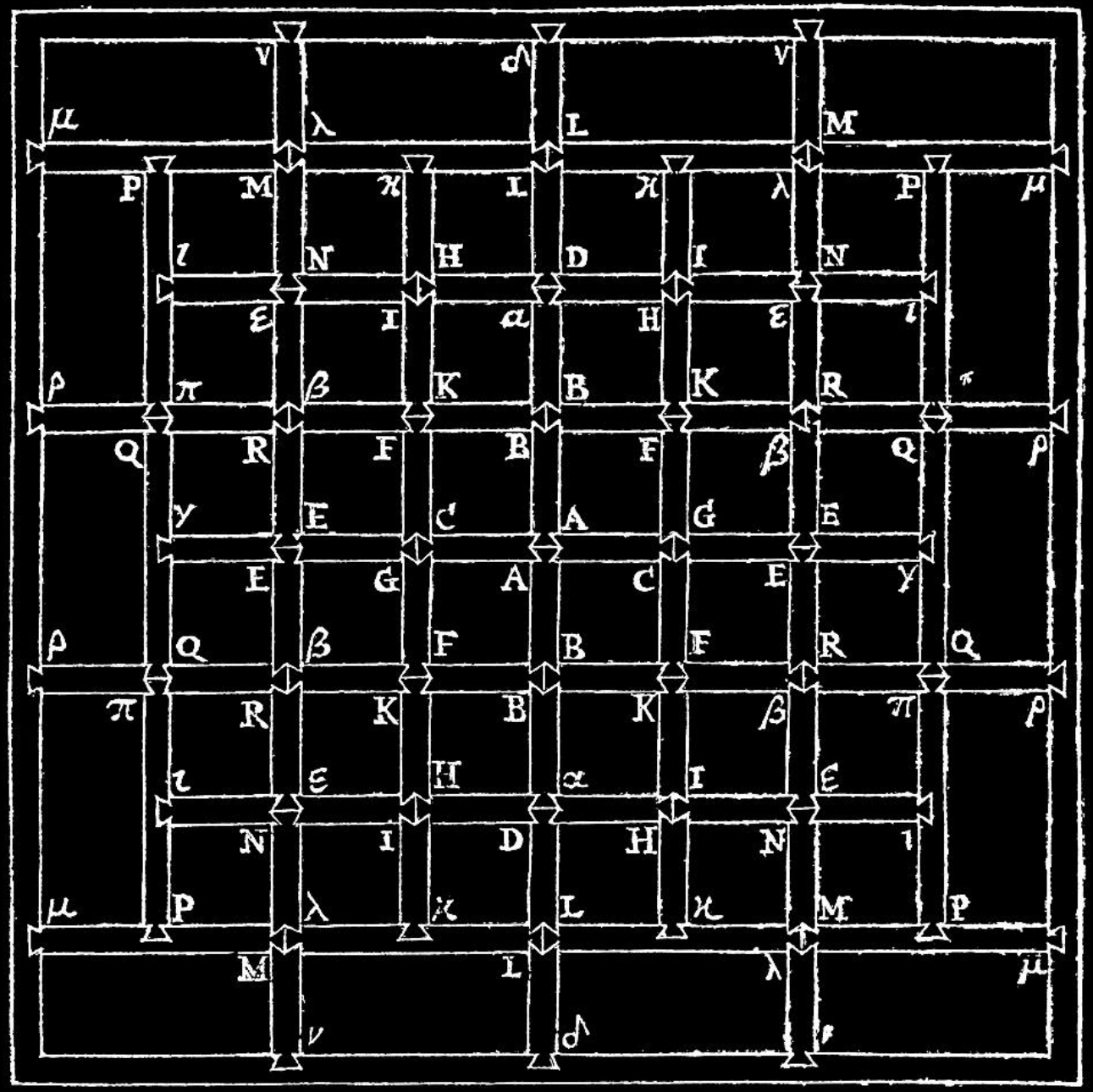
Italian Architect wrote the "7 books on Architecture" and helped define the "5 orders of architecture"

John Wallis 1616-1703

English Mathematician

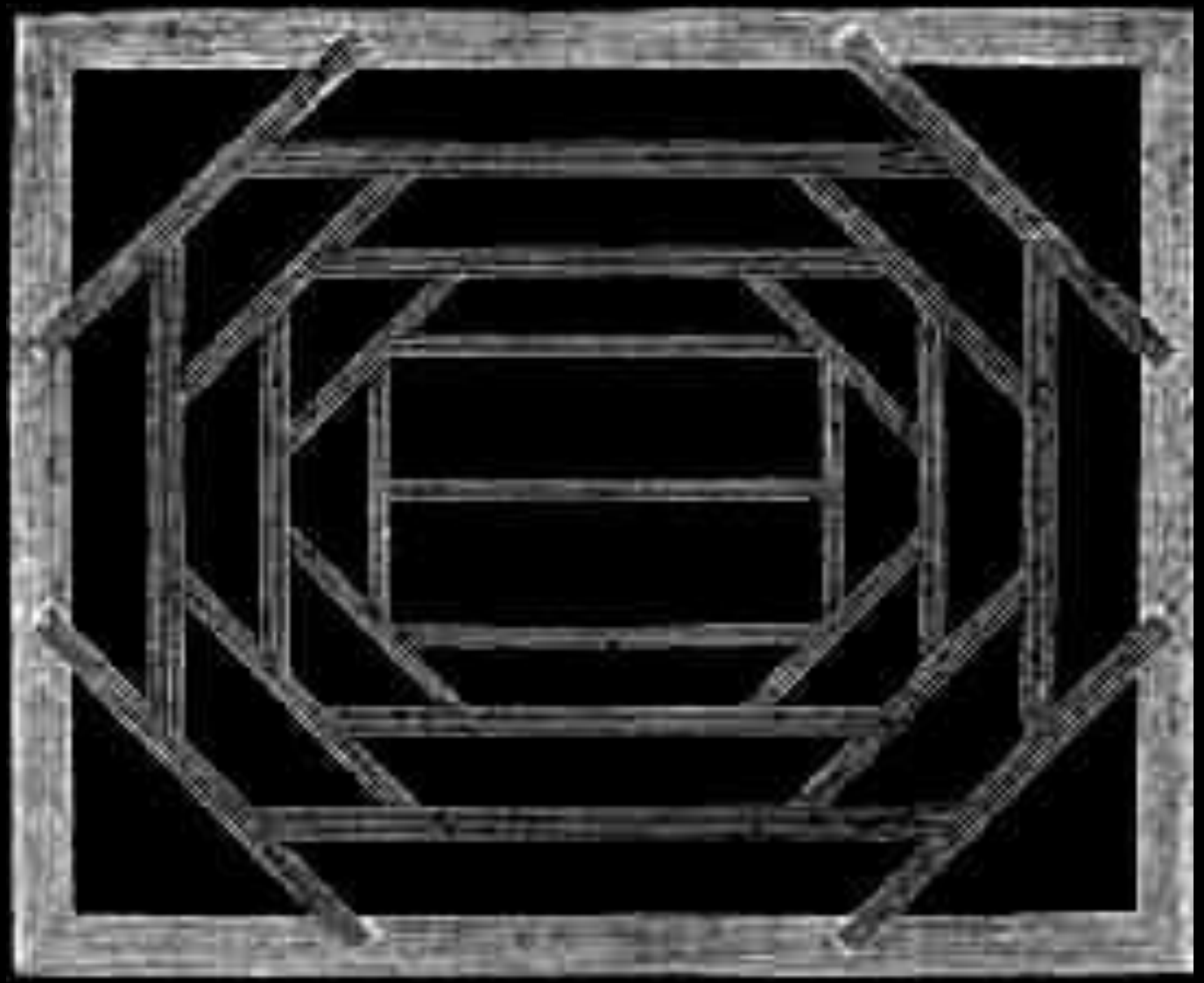
Author Opera Mathematica

Gave us ∞



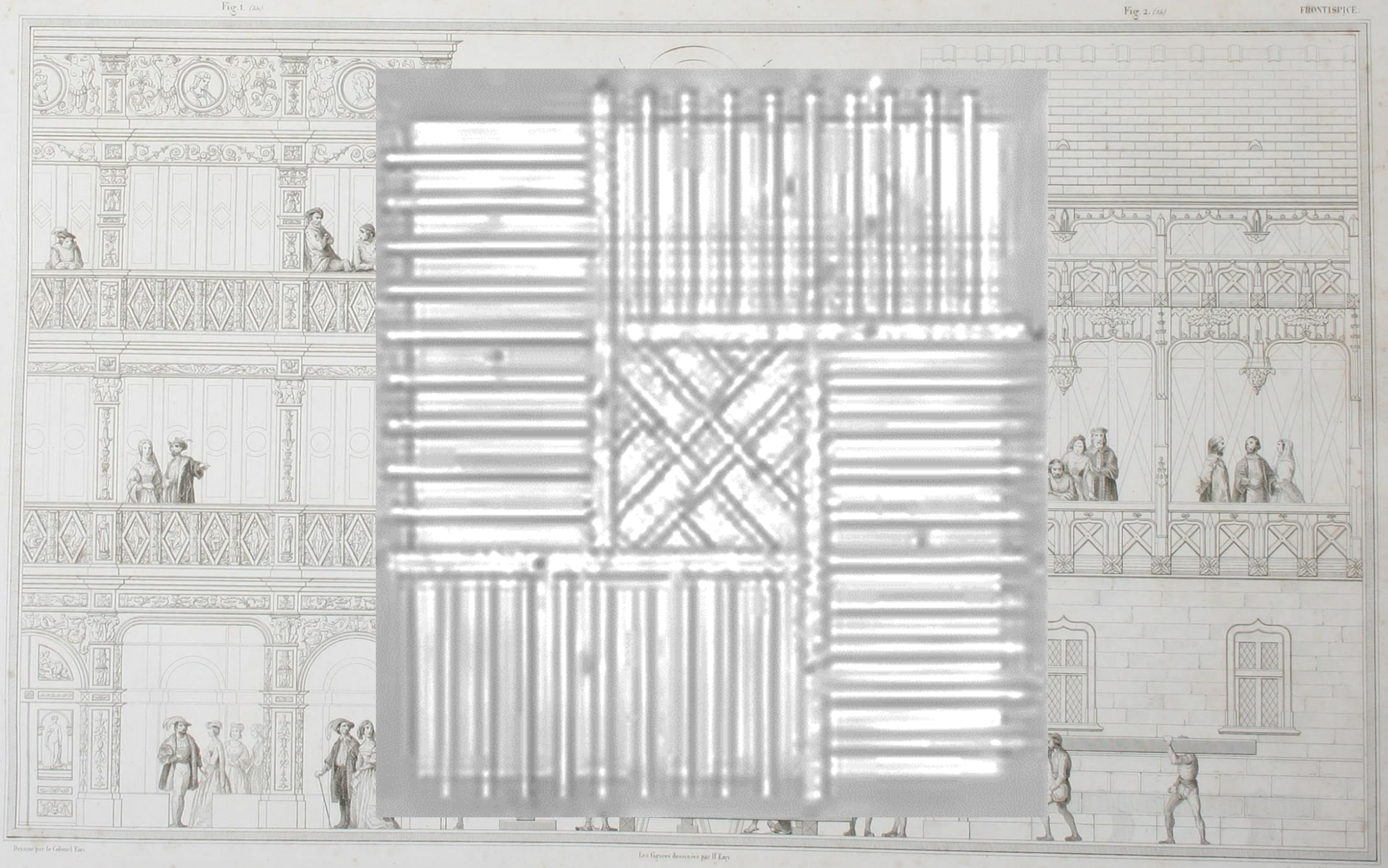
Thomas Tredgold 1788-1829

English Engineer and Author of
Elementary Principles of Carpentry



Armand Rose Emy 1841

Traite de L'Art de la Charpentrerie



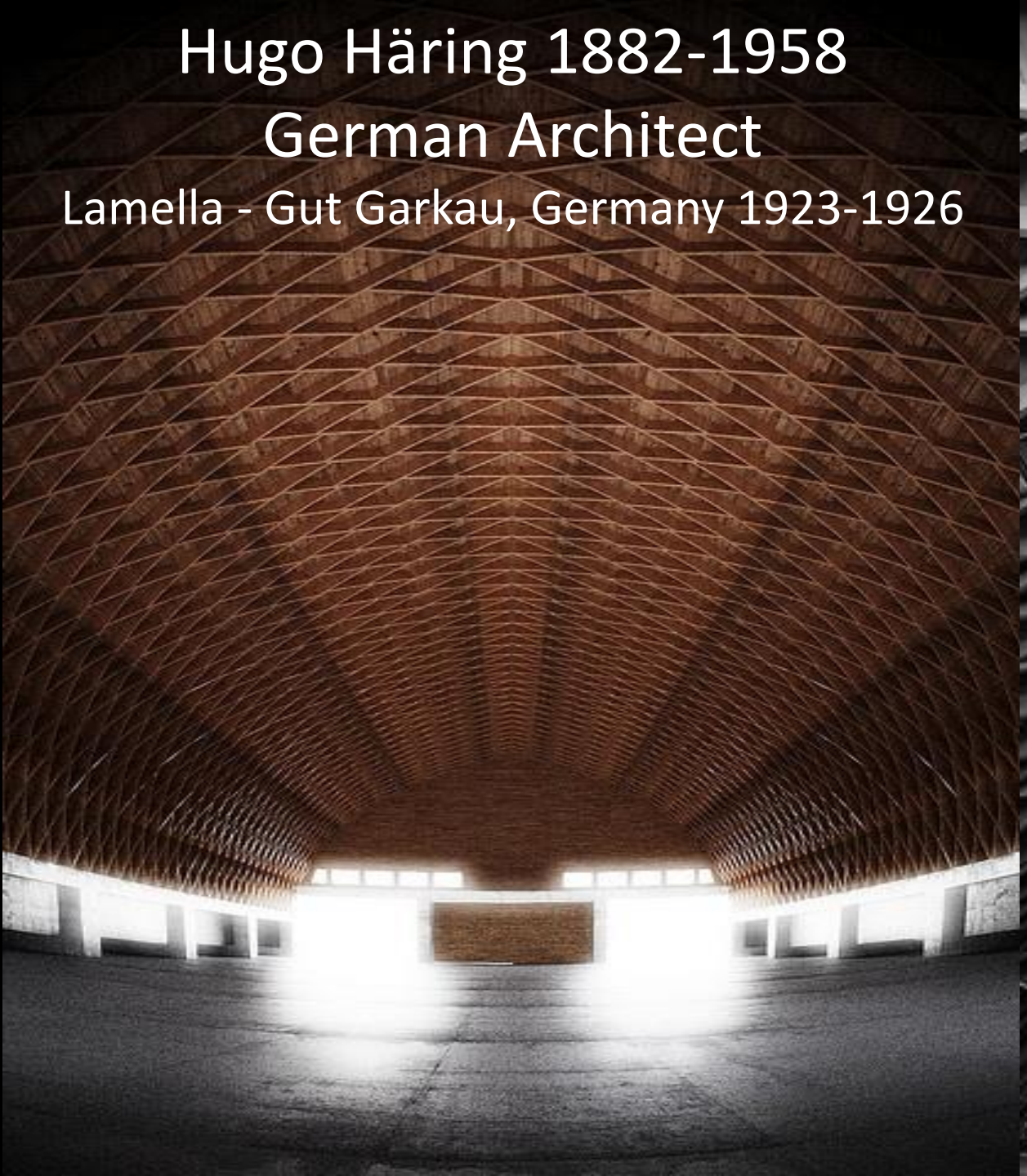
Tower of the Schools of the Quadrangle, Bodleian Library, Oxford

Friederich Zollinger
1880-1945
German Architect and Engineer

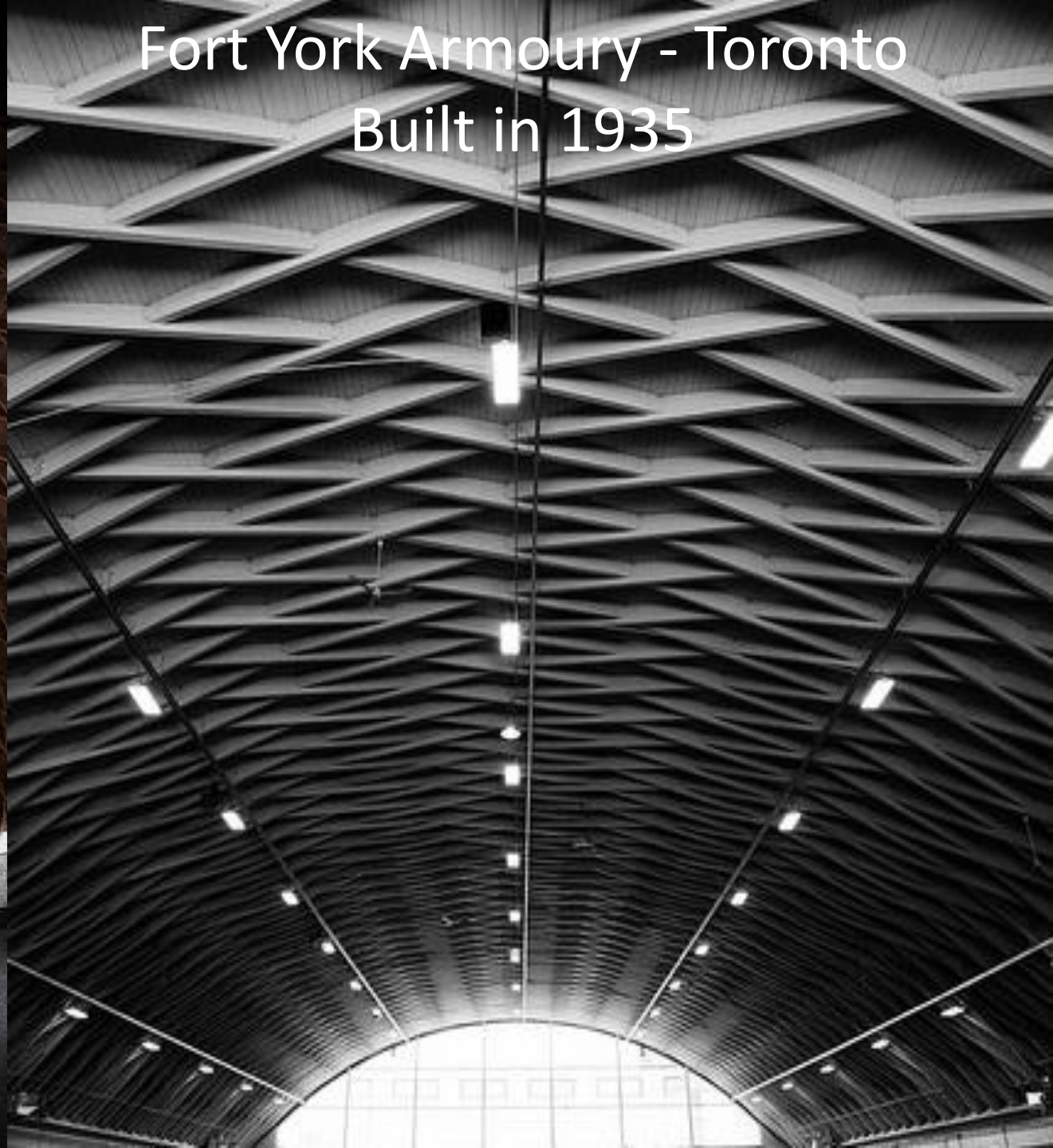
Lamella “Zollinger Roof”,
Merseberg Germany 1920s

Bild 4. Doppelhaus mit Zollbau-Lamellen-Dach im Bau (Gensaer Straße, Merseburg 1922)
Fig. 4 Semi-detached house with „Zollbau-Lamellen" roof under construction

Hugo Häring 1882-1958
German Architect
Lamella - Gut Garkau, Germany 1923-1926



Fort York Armoury - Toronto
Built in 1935

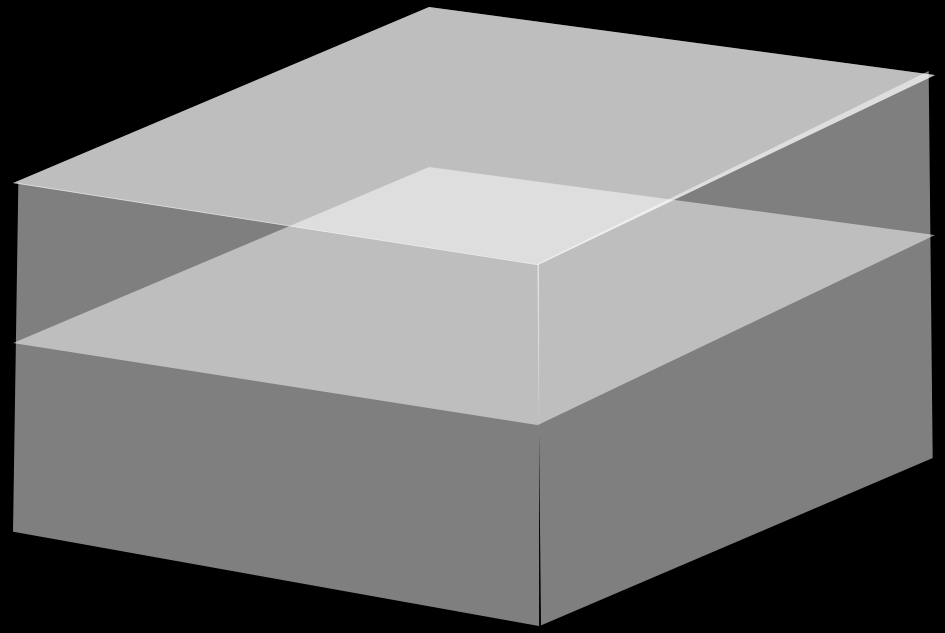


Case Study 1

Simple Grid – Toronto
Architect - Top Secret
Blackwell Engineers

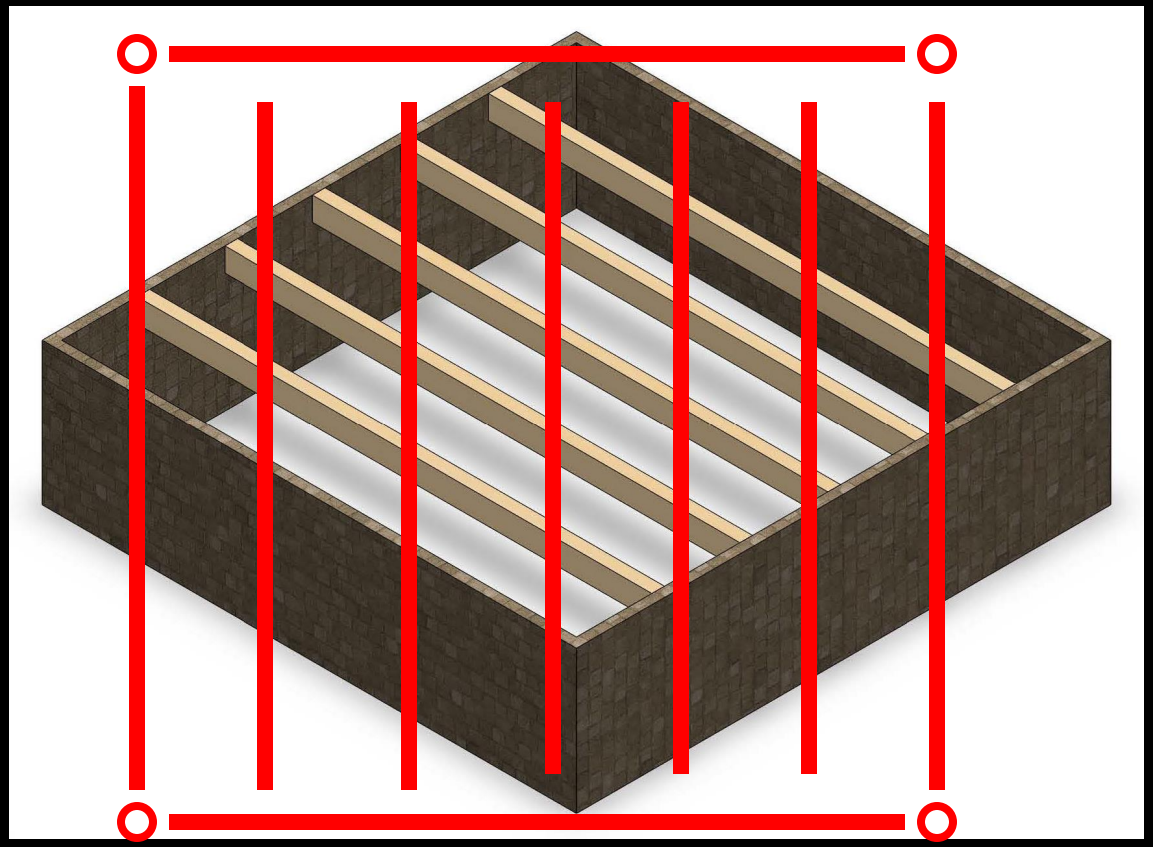
Objective

Shallow depth
Long spans
Stringent vibration criteria

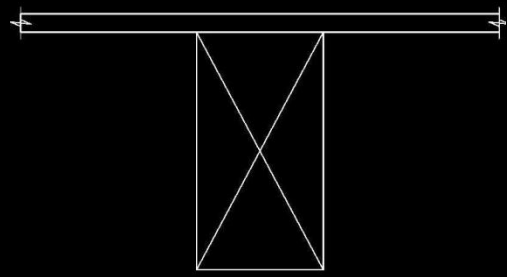


Option 1 – Conventional Framing

Designed for Strength and Deflection



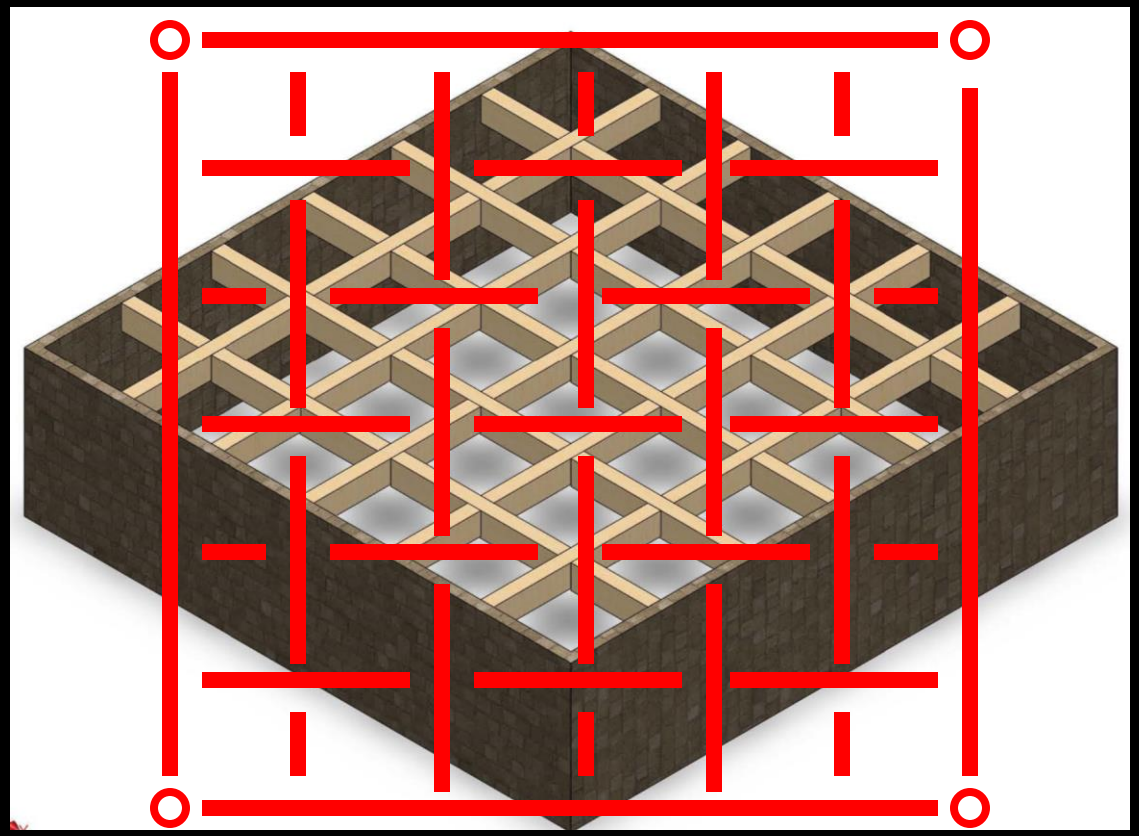
Piece Count – 5
Deepest Member – 494
Total Volume – 7.07 m^3



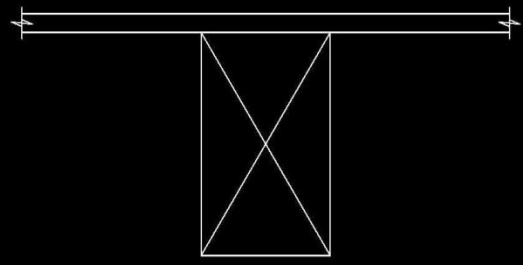
265x494

Option 2 – Reciprocal Framing

Designed for Strength and Deflection



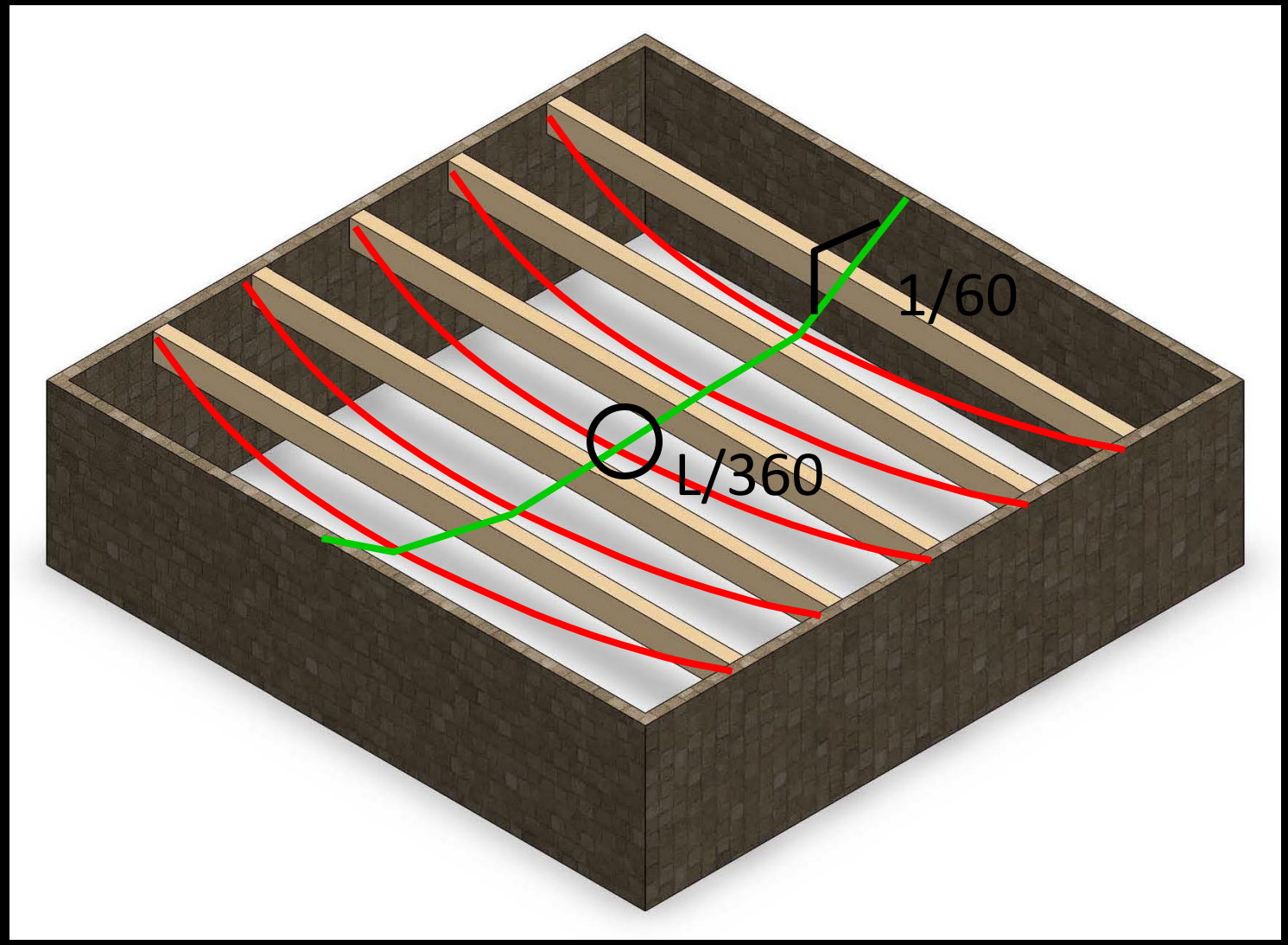
Piece Count – 10
Deepest Member – 456
Total Volume – 12.2 m^3



265x456

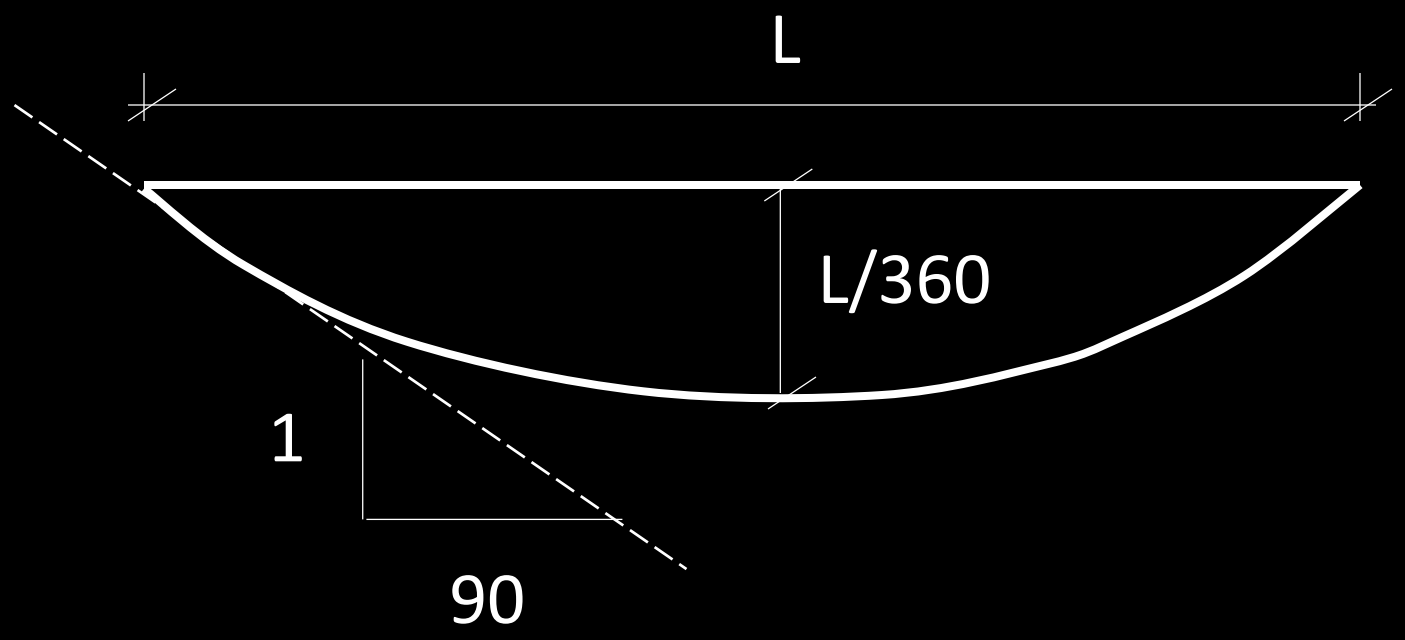
Deflection

Do we take L/360 for granted?



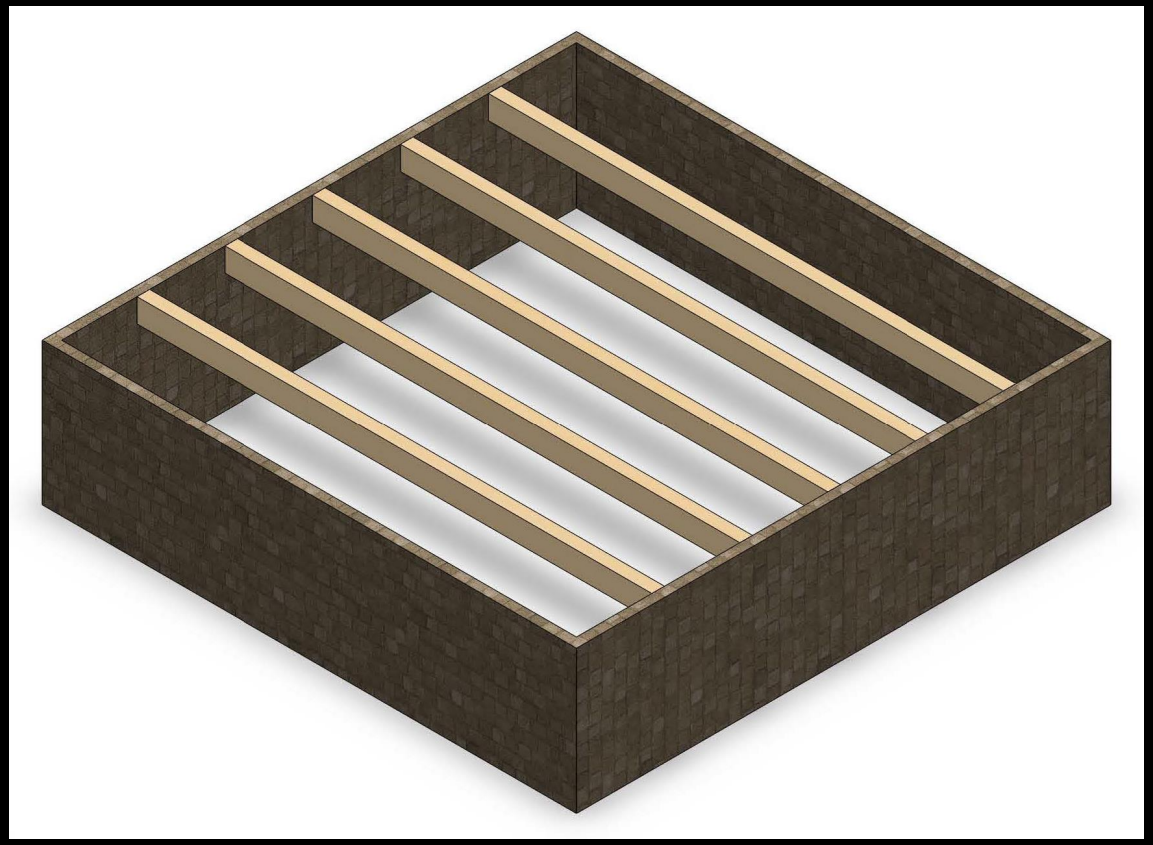
Deflection

So what do we do instead?

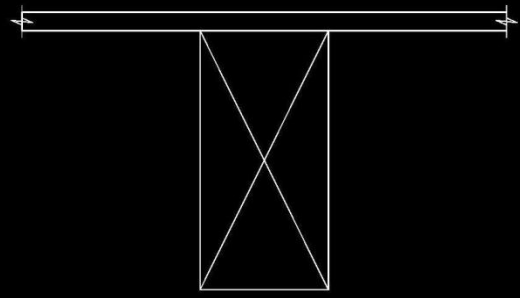


Option 3 – Conventional Framing

Designed for Strength and Updated Deflection Criteria

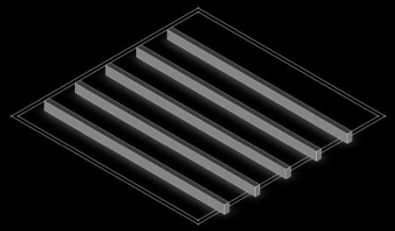


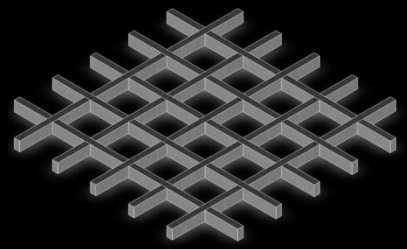
Piece Count – 5
Deepest Member – 570
Total Volume – 8.16 m^3

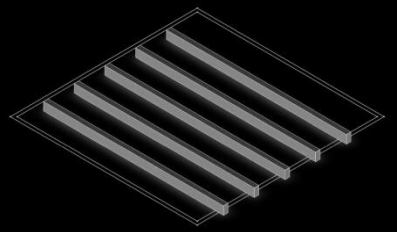


265x570

Summary

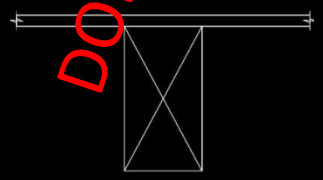


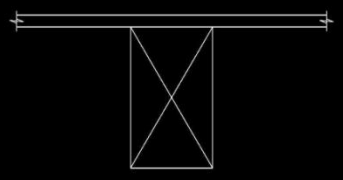


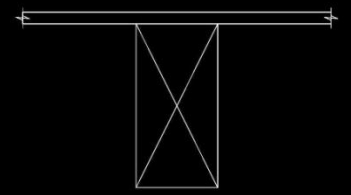


	Standard Framing	Reciprocal Framing	Standard Framing (Δ)
Piece Count	5	10	5
Depth (mm)	494	454	570
Total Volume (m^3)	7.07	12.2	8.16

DOES NOT WORK

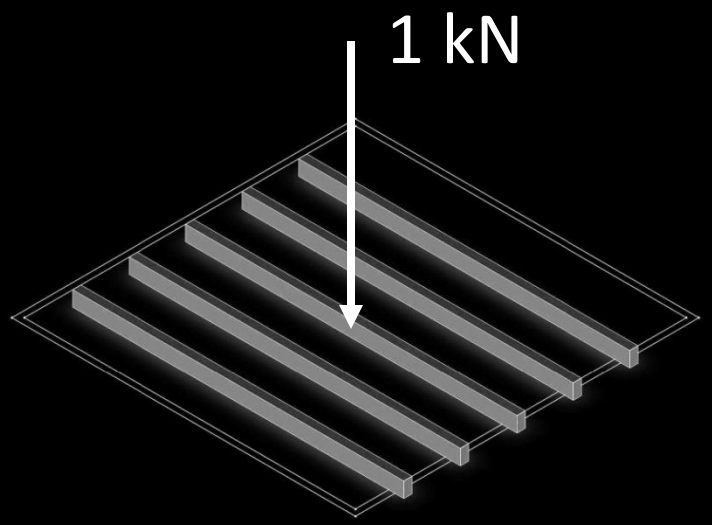




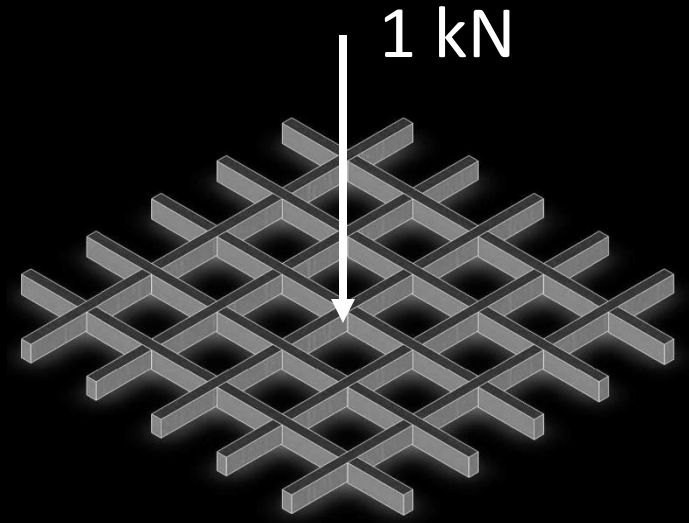


Other Considerations

Vibration



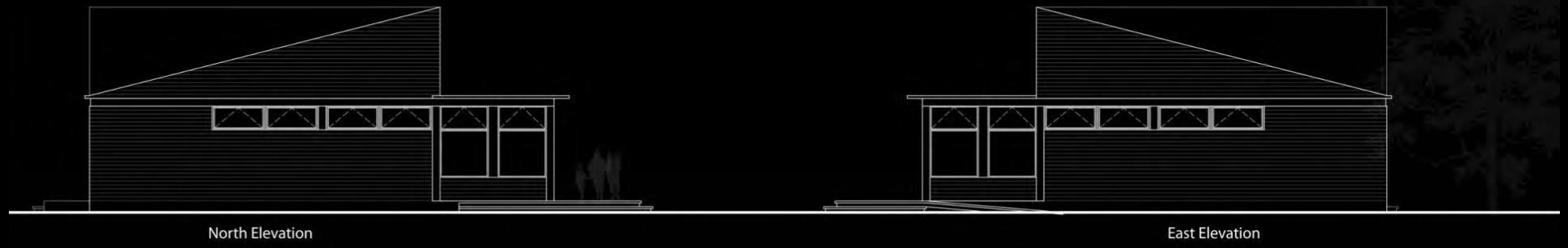
0.6 mm

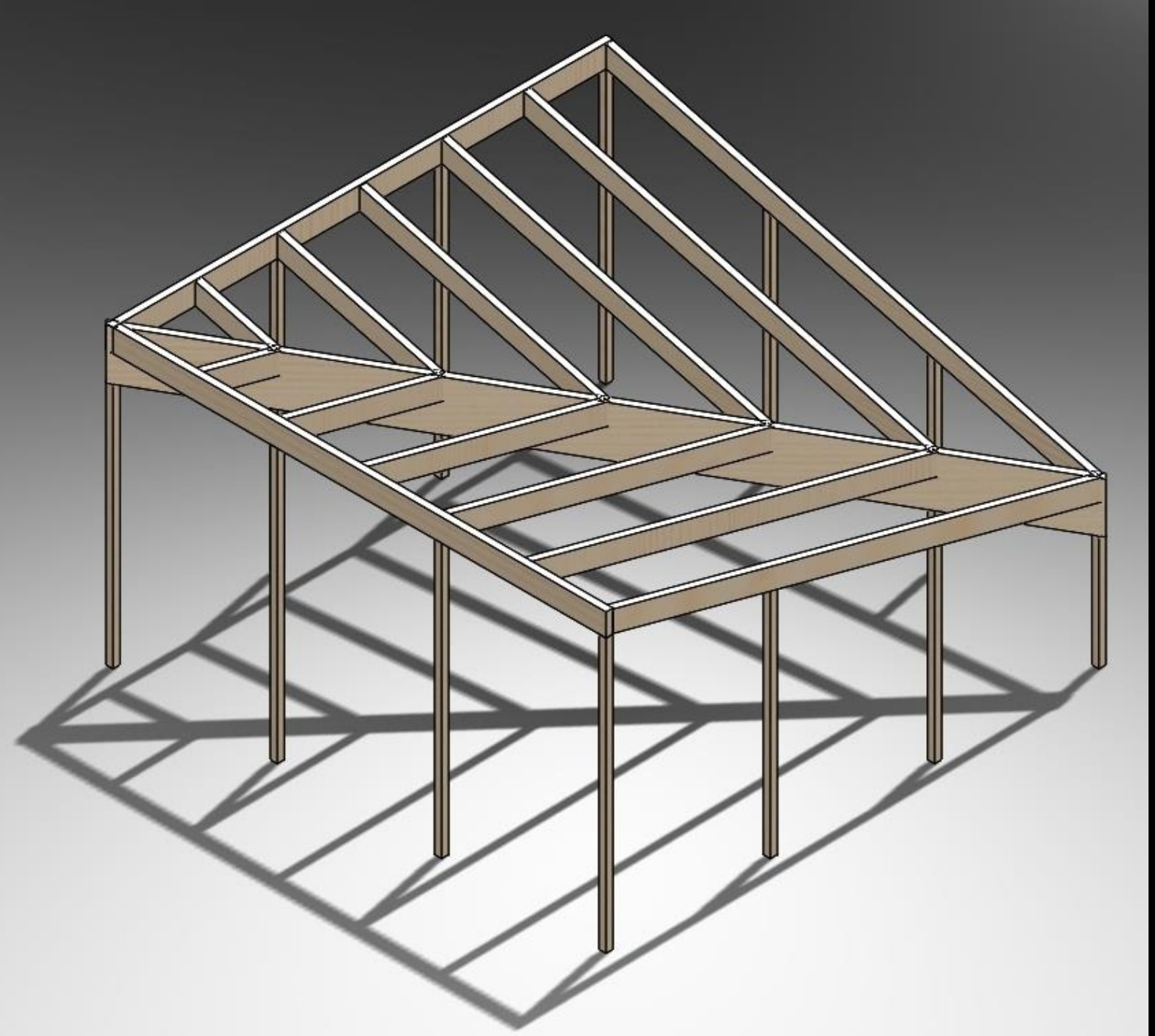


0.3 mm

Case Study 2

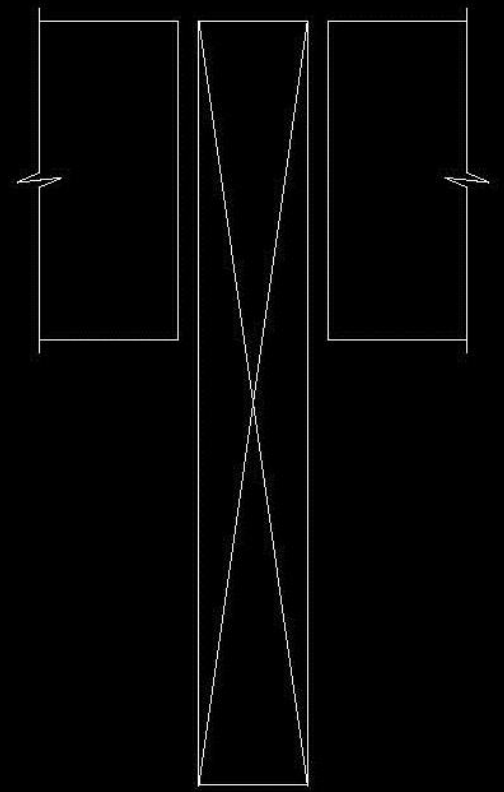
Indian River Pavilion – PEI
David Sisam
Blackwell Engineers
Construction Documents

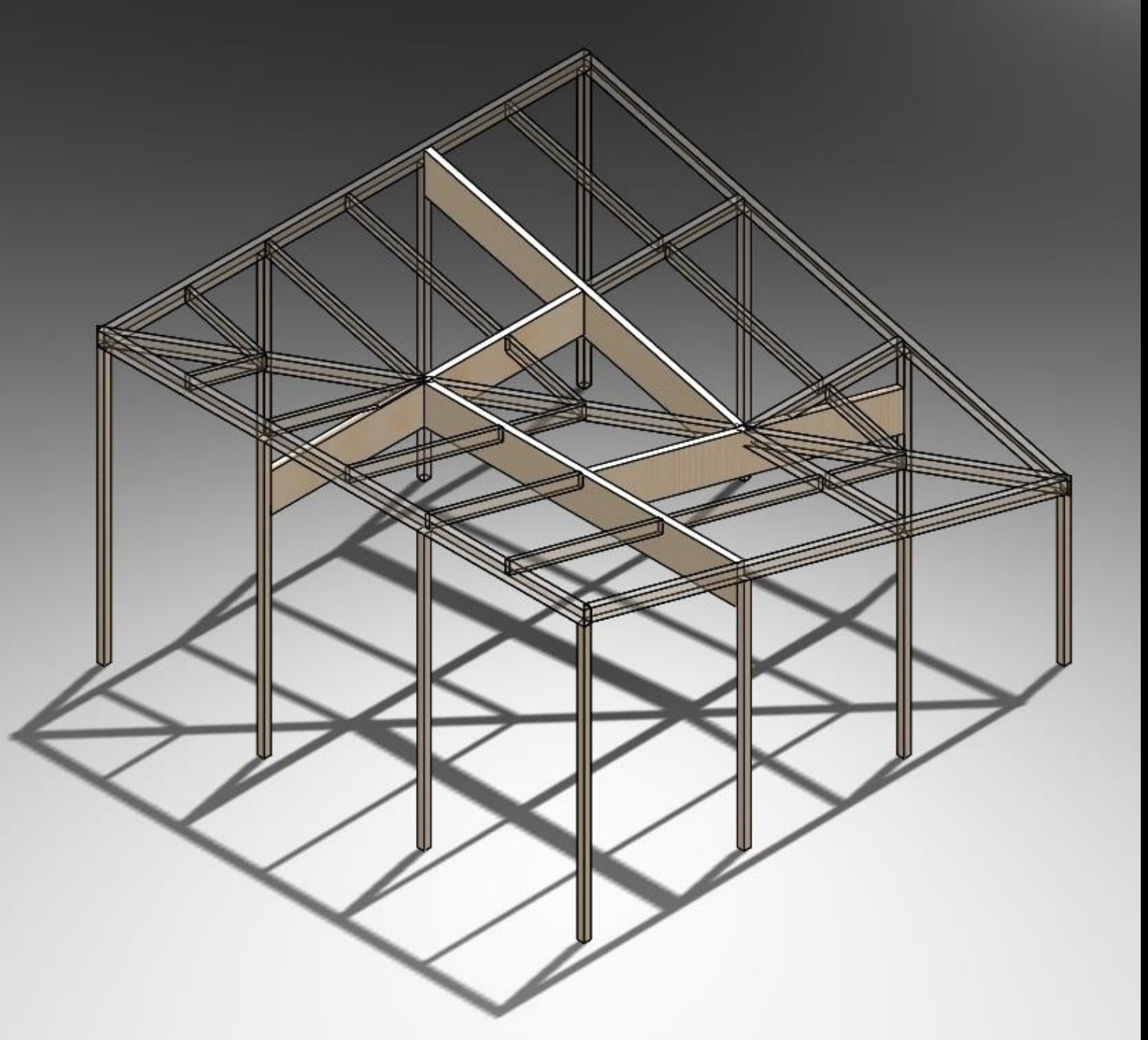




Option 1
Valley Framing

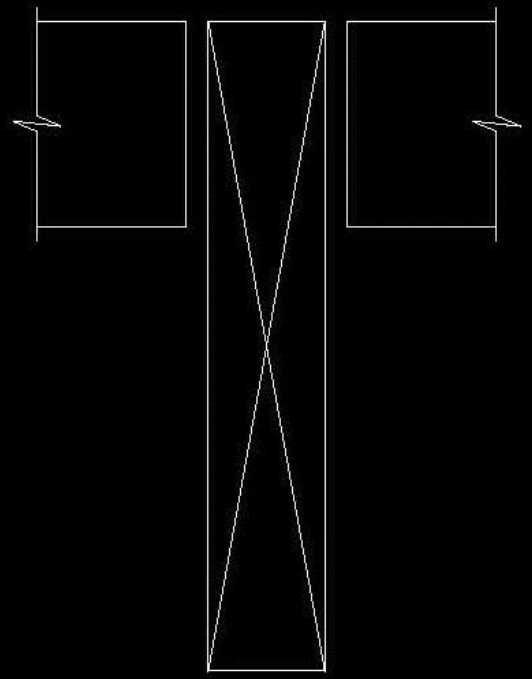
Piece Count – 15
Total Volume – 5.8 m^3
Largest Piece – 731 kg

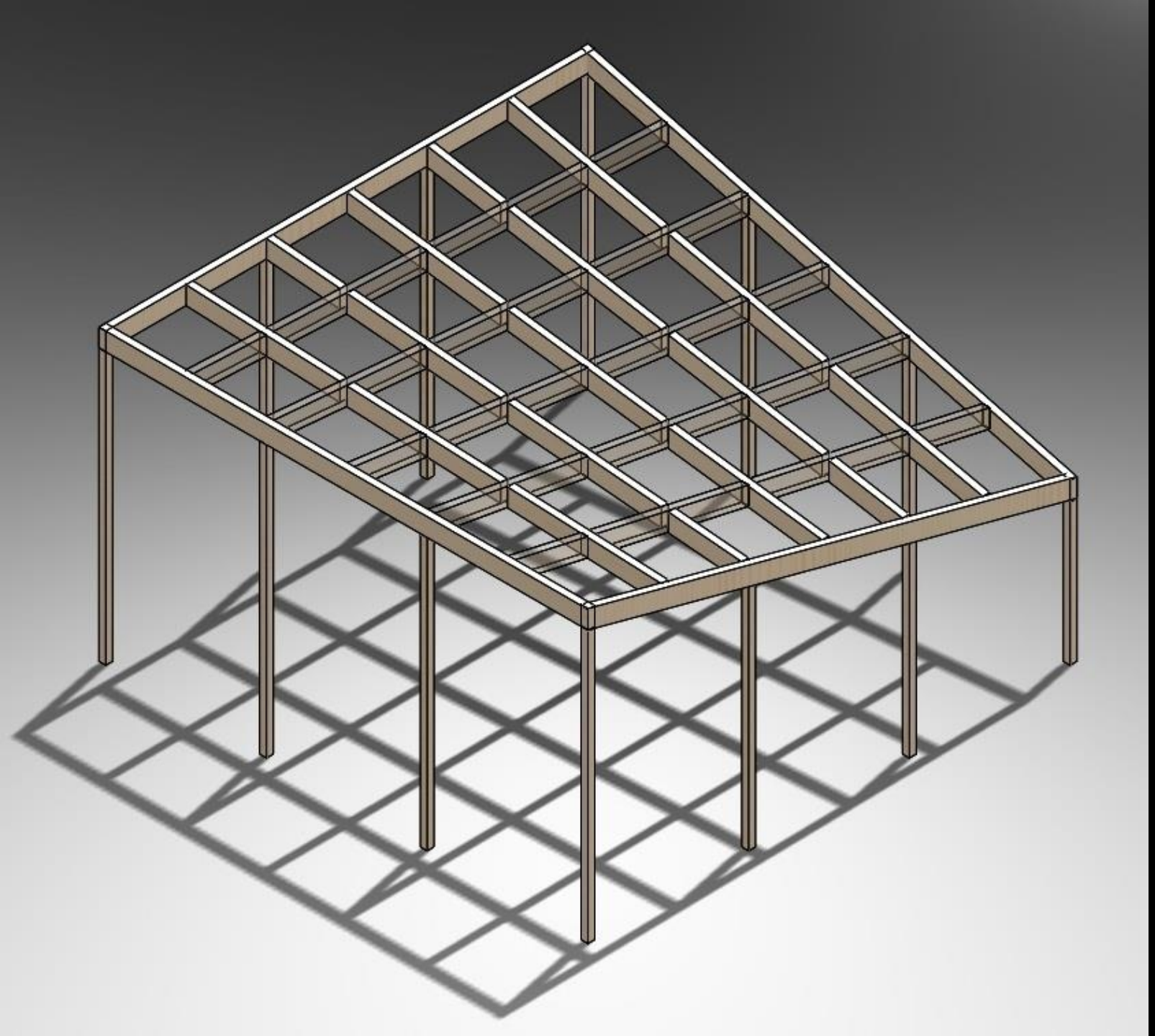




Option 2
Reciprocal Beam

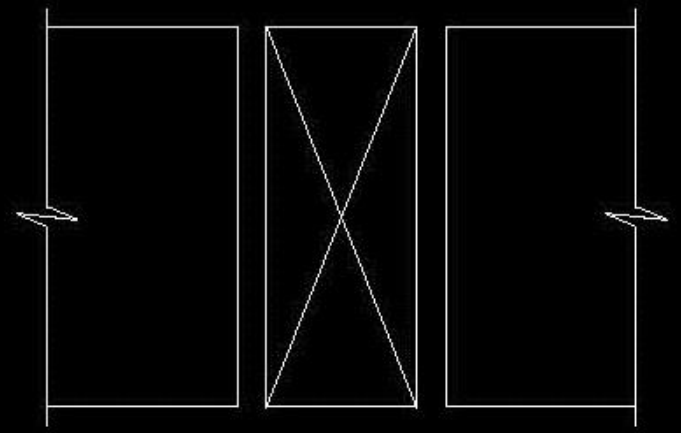
Piece Count – 37
Total Volume – 4.8 m^3
Largest Piece – 268 kg



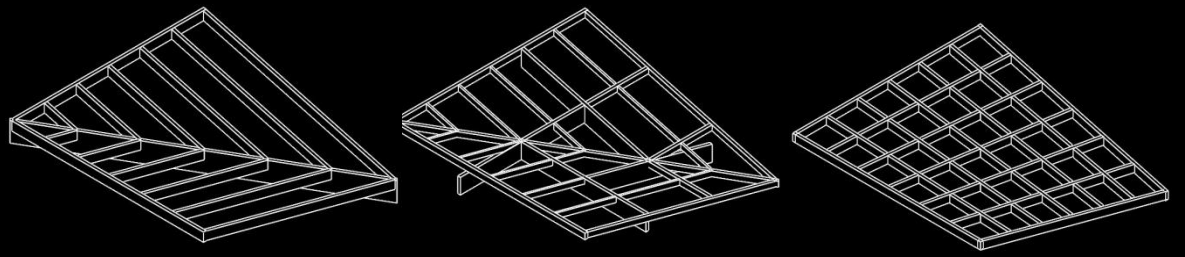


Option 3
Reciprocal Joist

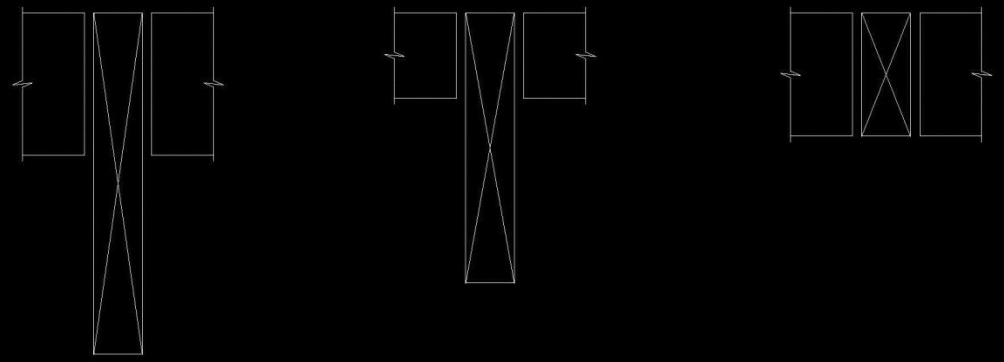
Piece Count – 47
Total Volume – 5.6 m^3
Largest Piece – 60 kg



Summary



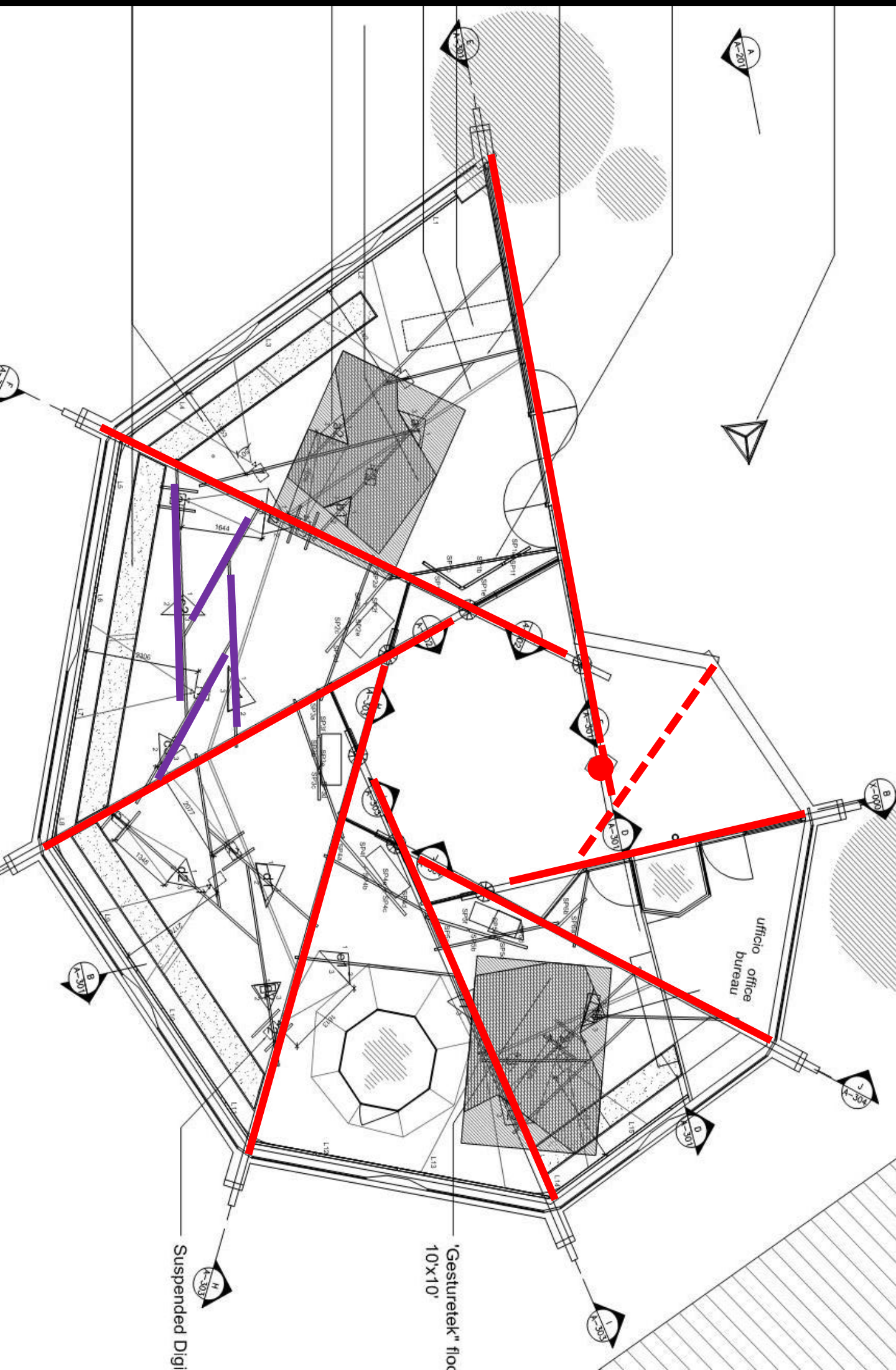
	Valley Beam	Reciprocal Beam	Reciprocal Joist
Piece Count	15	37	47
Total Volume (m^3)	5.8	4.8	5.6
Largest Piece (kg)	731	268	60



Haltia Nature Centre
Rainer Mahlamäki
2013

Discovery Center, Ventura California
Restored 1940s Lamella

Canadian Pavilion at Venice Biennale (BBPR, Milan Architect 1958)
Drawing by 41° to 66° Team led by John McMinn 2008



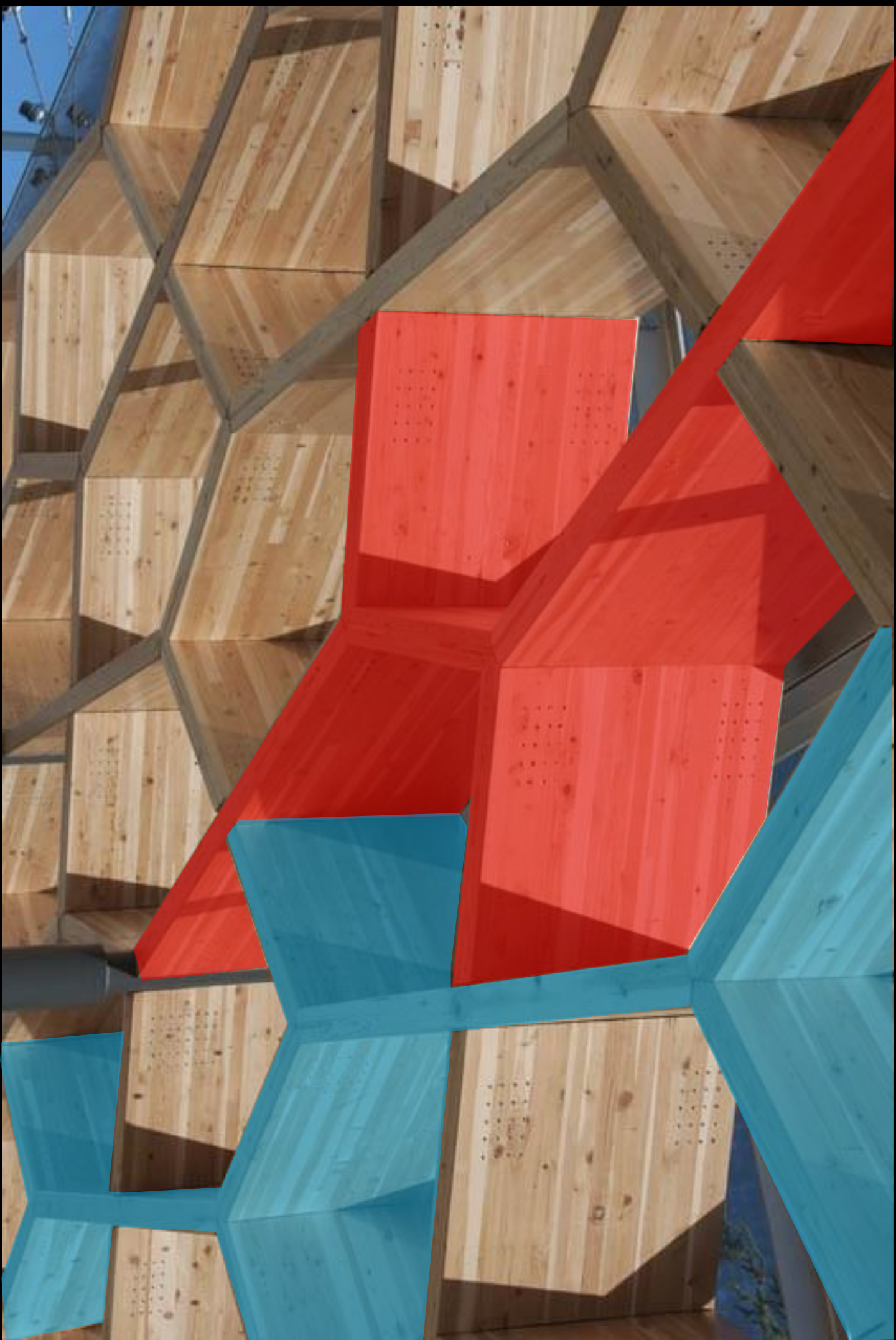
Bunrāku Theatre – Kazuhiro Ishi

Ross Creek Picnic Pavillion
Ted Cavanagh / Coastal Studio
and Studio North 2010

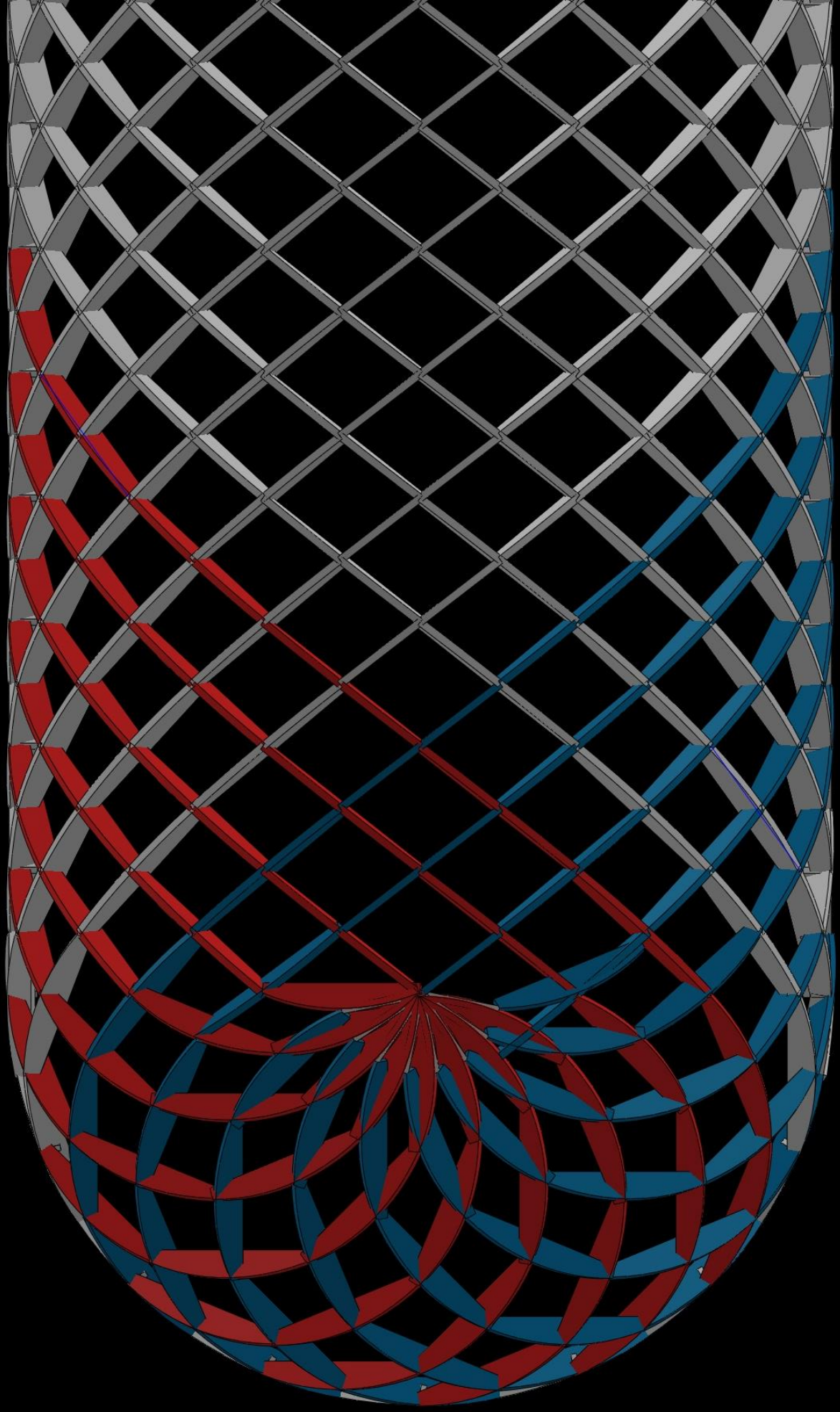
Hale County Animal Shelter
Rural Studio 2006


Genie S-65
Certified Equipment
416-747-7878
1-888-714-7070

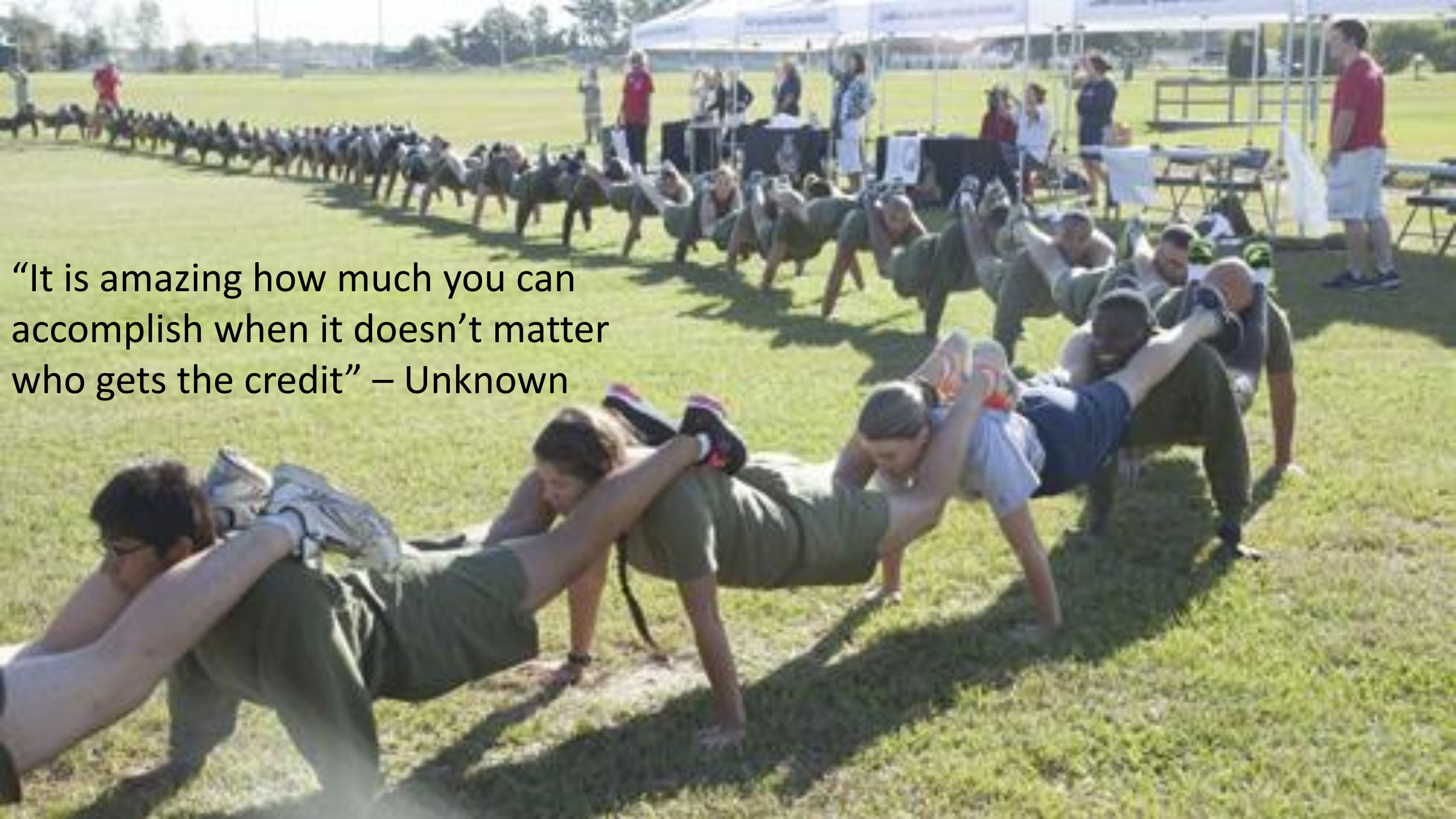
UBC Transit Shelter – Fast + Epp



Jack Layton Ferry Terminal, Toronto
KPMB Architects



NCFS Longhouse – Toronto, 2009
Levitt Goodman Architects
Blackwell Engineers


“It is amazing how much you can accomplish when it doesn’t matter who gets the credit” – Unknown