

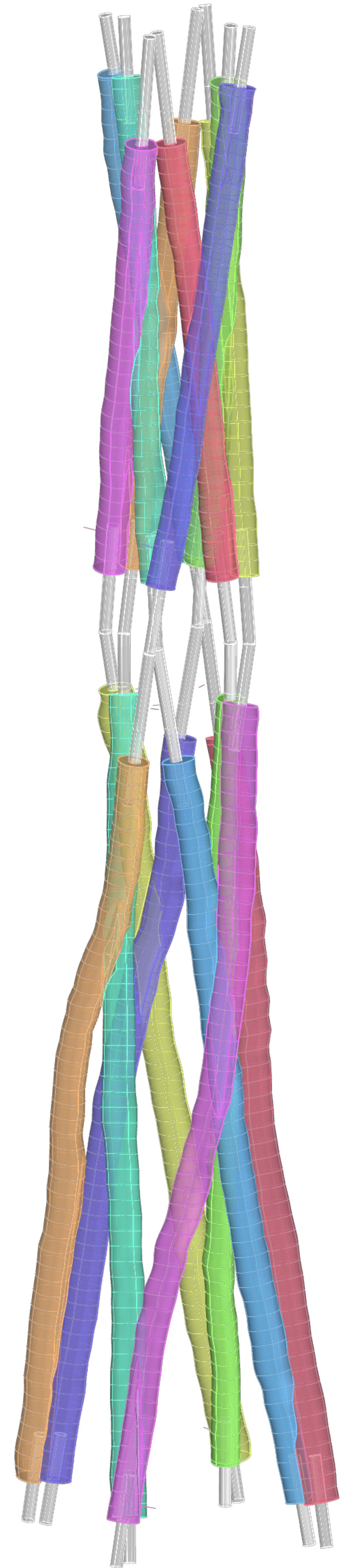
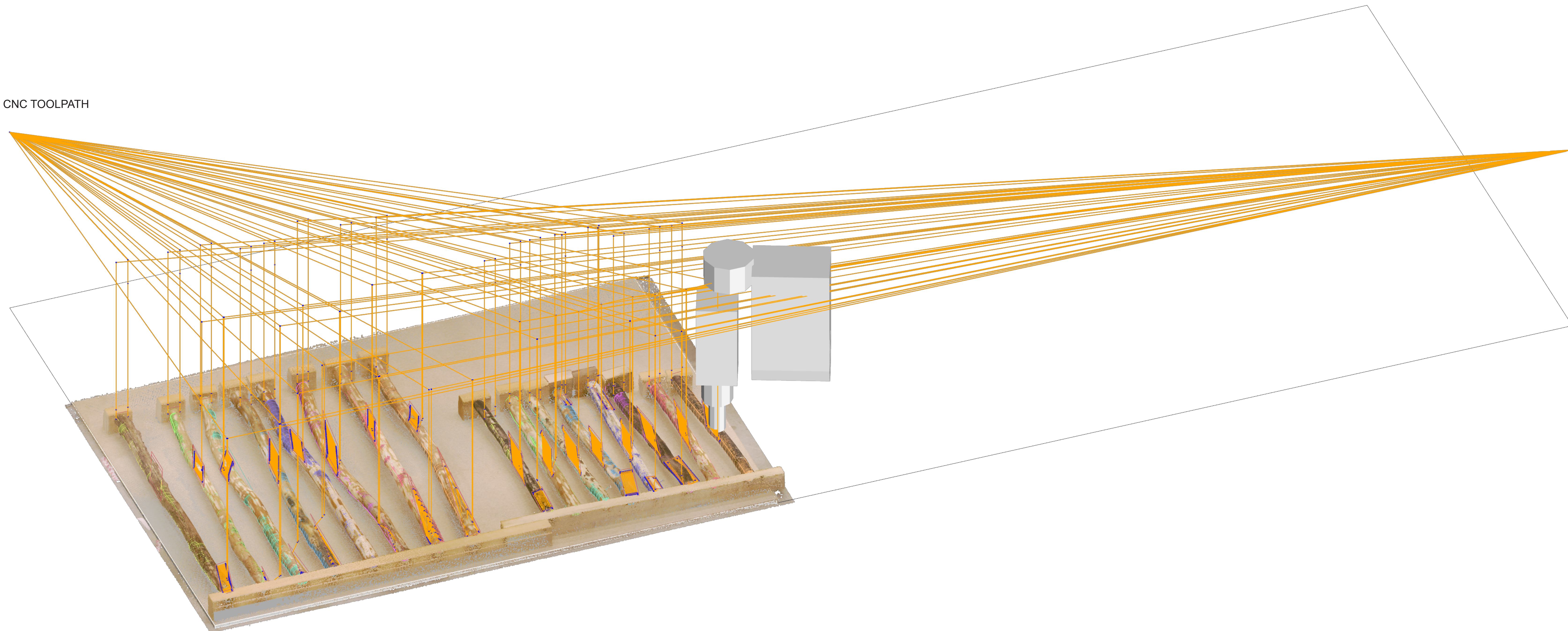


FOUND WOOD

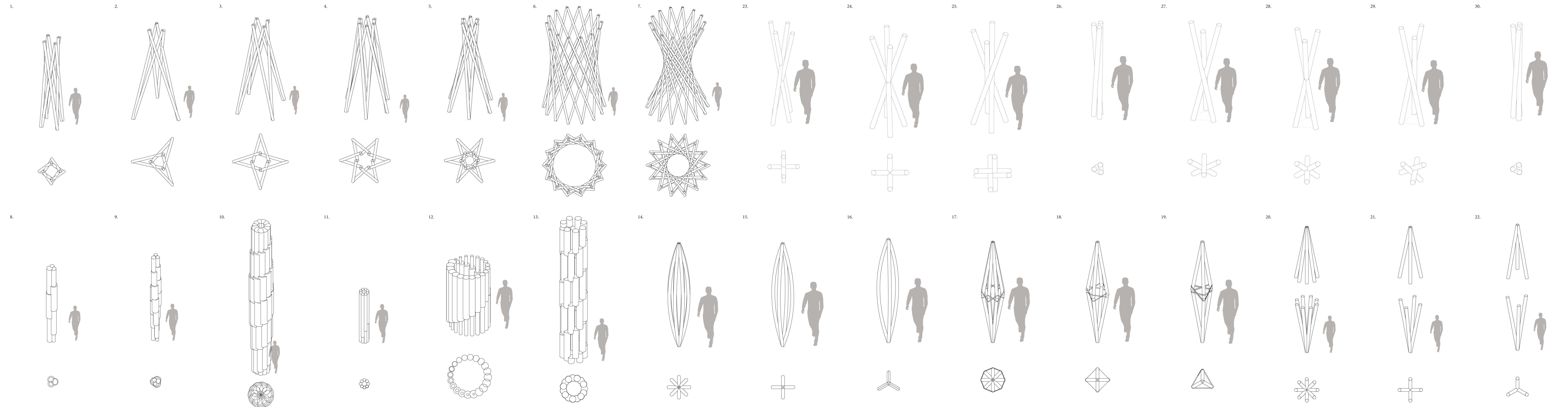


POINT CLOUD SCANS TO BERP

CNC TOOLPATH



ARRANGEMENT OF ELEMENTS



The Compound Column:

Based on these constraints, I arrived at a double-structured geometry (henceforth referred to as a compound column), in which six identical timber trusses are joined in three pairs, which meet at each of the column, and spread to its equivalent through its full height (Fig 4.1.2). Steel elements are used in tension to resist the outward spread of the column at its mid-height. This spread provides global buckling resistance.

Post-Tensioning:

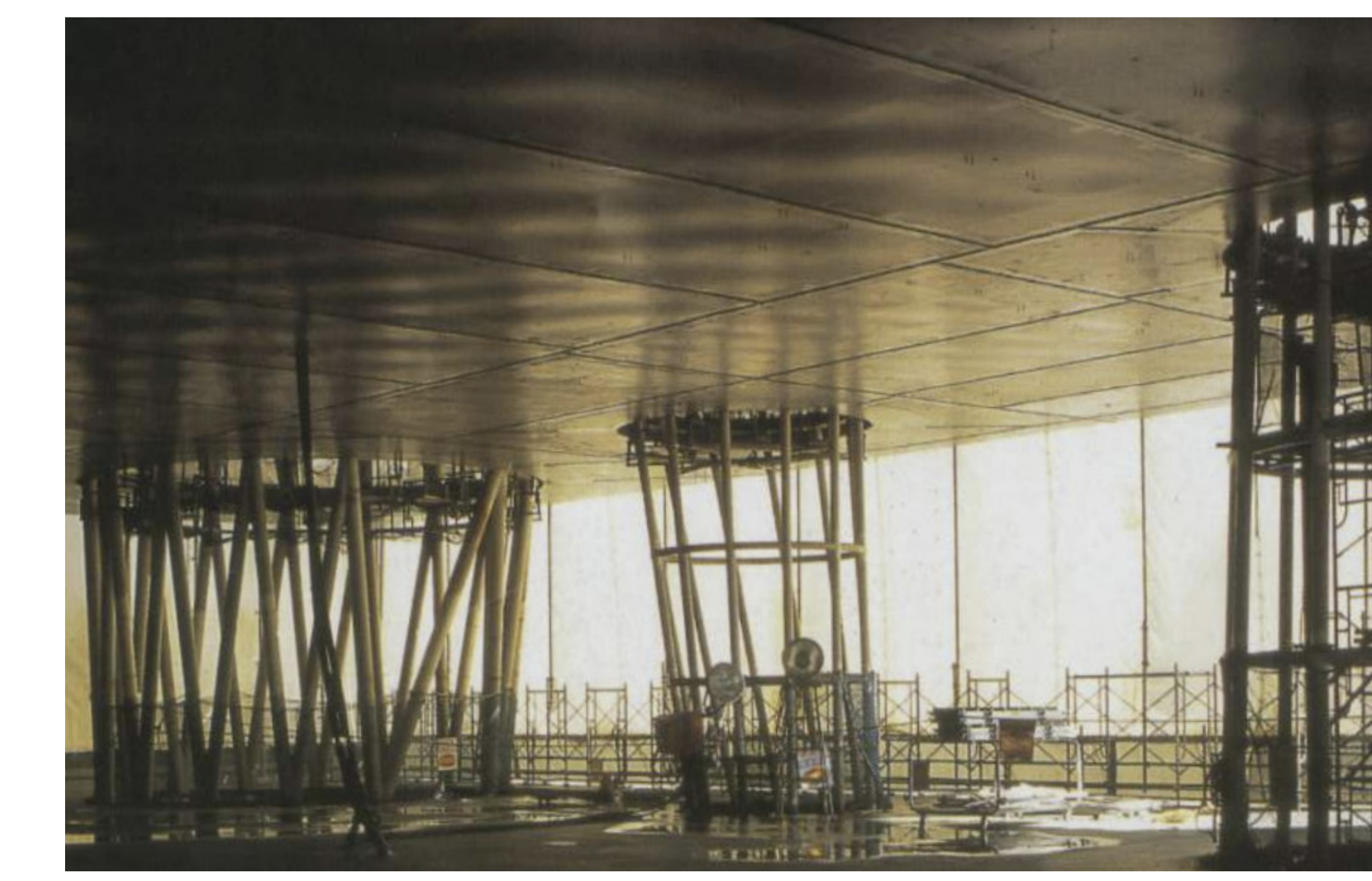
Compressively connections in the compound column are adequate under normal vertical loading, but when the column is being moved on site, or if a more robust rigidity from a roof under windloading, these connections will be subjected to tension.

Fig 4.1.2 Post-tensioning allows for compression-only structures.

Post-tensioning allows additional compression to be introduced to the compound column, such that compression connections will give rise to its tension, even when the column is subjected to uplift or is being moved on site (Fig 4.1.3). A central cable connected to bearing plates at each end of the compound column can be tensioned to add additional compressive load to the column as a whole.

Fig 4.1.2 'A' 'compound column' in whole-timber

NEW STRUCTURAL SYSTEMS IN SMALL-DIAMETER ROUND TIMBER
Aunimas Bukauskas - University of Cambridge



SENDAI MEDIATHEQUE, JAPAN
Architect: Toyo Ito

**EPFL
IBOIS**

Truss

Most raw wood truss systems relies on steel connections^{1,2,3,4} because of complex nodes when multiple beams meet at the same point (valence) larger than two(36, 45, 48, 72, 75, 90, 108, 144). A tree trunk is used as a linear beam element interconnected side-to-end. Trusses show a structural advantage of raw wood by exploiting a maximum use of timber biomass. In general, the design of the easily fabricated metal connectors is emphasized to assemble many similar beam elements, even though the sustainability and ease of manufacturing are questionable. The wooden trusses are applied to bridge structures as well (4, 161). Another option would be to form a Vierendeel truss to avoid the complex metal connectors (184). Additionally, there are methods to connect multiple timbers to form tree-shaped columns (25, 36). Other techniques focus on hybrid timber- and steel connections (62) to ease the fabrication and assembly. Minimal steel connectors were also used in the Lausanne observation tower by Julius Natterer (111). Therefore, it is hardly possible to employ only wood-wood connections for large-span structures made from raw timber considering the multi-valence truss nodes (see Figure 3.5).

Fig 4.5.5 - Trusses from raw wood are a mainly composed from steel connectors and mechanically rounded timber.

¹<https://rtdeditions.com/products/timber-festival-bonds-grocery-store/>
²<https://www.naturetimber.com/index.php/home>
³<https://carpenterswork.com/projects/nature-campus-the-north-center/>
⁴<https://rtdeditions.com/products/timber-festival-bonds-grocery-store/>

Chapter 9. Raw wood Cross and Top-to-side joints for Trusses

9.5 Assignment Problem

A given set of timbers alters the initial design (see Figure 9.18). When trees were ordered from the forest within 15 cm radii, the delivered wood had taper, curvature and sectional differences up to 2-2.2 cm in radius. The assignment strategy is needed because two large timbers might be colliding, or smaller beams might not form a connection zone. First, all the beams are scanned at one time, and the points cloud is cropped to individual beams. Second, skeletonization is performed on each point cloud using a Cylinder-fit method. Third, the cost is assigned for each beam based on length and radii. Fourth, the assignment is made using a Hungarian method⁵. The search criteria for the Hungarian Algorithm was length of a beam. The indexing is needed to select the suitable geometry for fabrication within a group of self-similar elements. When the assignment solution is found, the initial design is updated concerning the oriented point clouds. These assignment findings resulted in the global design changes such as reducing beam thickness, reorientation of central parameters, and better cost estimation per element so that two small or too large beams would not be positioned close to each other (see Figure 9.20). Lastly, a small change like a few centimeters difference in a tree radius influences tool path generation, requiring less or more milling to ensure fast and secure fabrication.

Fig 9.19 - Beam assignment from the real to the digital state: a) Hungarian algorithm, b) initial model with equal radii beams, c) oriented scans, d) altered design.

⁵<https://rtdeditions.com/products/timber-festival-bonds-grocery-store/>
⁶<https://www.naturetimber.com/index.php/home>
⁷<https://carpenterswork.com/projects/nature-campus-the-north-center/>
⁸<https://rtdeditions.com/products/timber-festival-bonds-grocery-store/>

DESIGN-TO-FABRICATION WORKFLOW FOR RAW-SAWN-TIMBER USING JOINERY SOLVER
Petras Vestartas - EPFL



TAMEDIA HQ, SEVEN STOREY WOOD OFFICE BUILDING, SWITZERLAND
Architect: Shigeru Ban

Dachaufbau

Schlammsiegel
Lavaschotter
Blumenlagen 3 x 4mm
3 Schichtplatte
Schiffmatten 20cm
Gefällschicht
Korksrot-Trass-Lehm Mischung

Kelleraussenwand

Stempflehm 45cm
Blumenlage 0.4cm
Schaumglas 15cm
Stumpfen 2 x 0.4cm
Stickerschicht

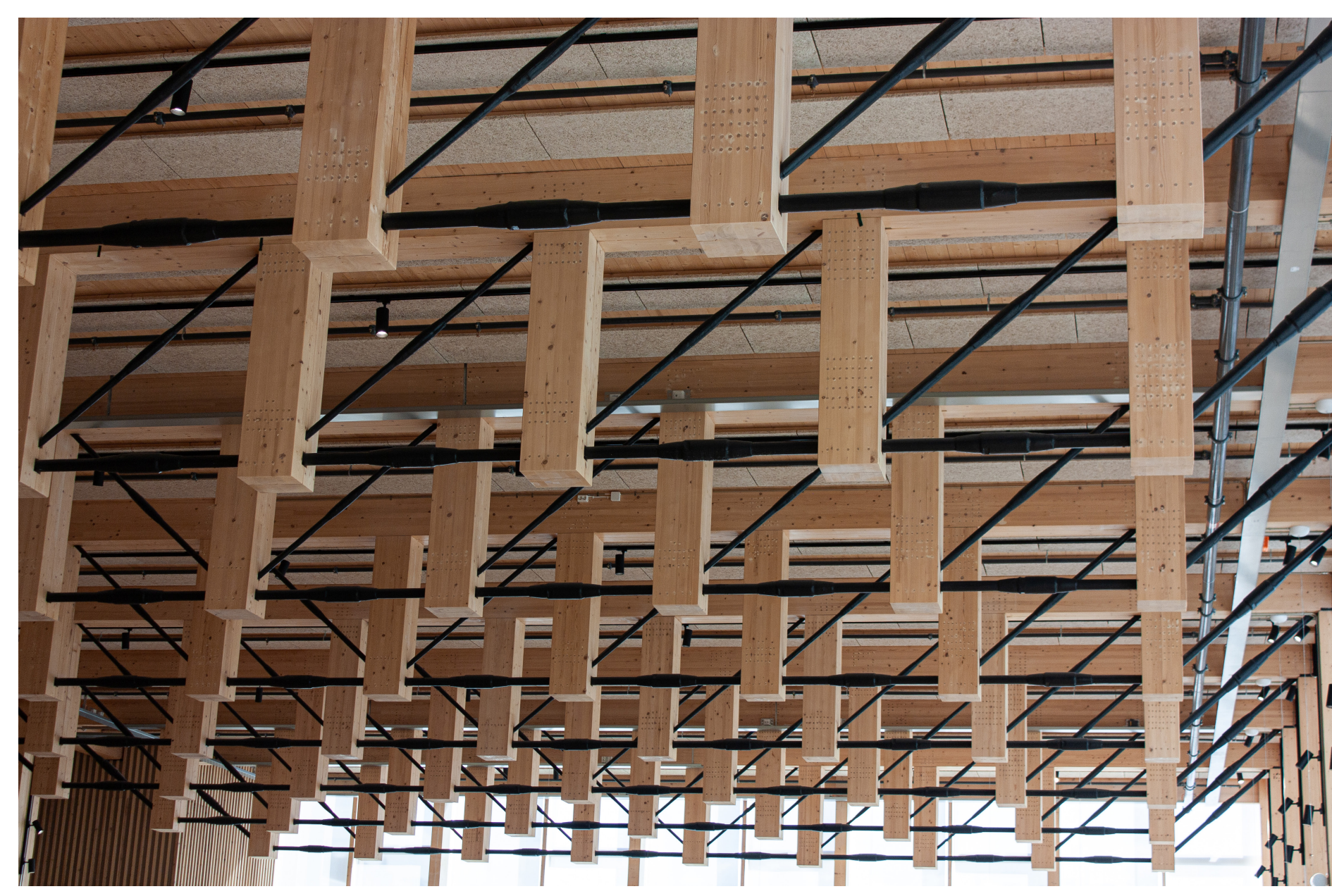
Wandaufbau

Doppelbaudecke
Schichtholz
Lehmbauplatten
Lehmputz

Bodenaufbau Küche

Fig 4.5.6 - Beam assignment from the real to the digital state: a) Hungarian algorithm, b) initial model with equal radii beams, c) oriented scans, d) altered design.

Villa Rauch, Austria
Architect: Roger Boltshauser & Martin Rauch



SARA KULTURHUS, SWEDEN
Architect: White Arkitekt

Human-in-the-loop Fabrication of 3D Surfaces with Natural Tree Branches

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Fig 4.5.7 - Beam assignment from the real to the digital state: a) Hungarian algorithm, b) initial model with equal radii beams, c) oriented scans, d) altered design.

Human-in-the-loop Fabrication of 3D Surfaces with Natural Tree Branches

Fig 4.5.8 - Beam assignment from the real to the digital state: a) Hungarian algorithm, b) initial model with equal radii beams, c) oriented scans, d) altered design.

Human-in-the-loop Fabrication of 3D Surfaces with Natural Tree Branches

Fig 4.5.9 - Beam assignment from the real to the digital state: a) Hungarian algorithm, b) initial model with equal radii beams, c) oriented scans, d) altered design.

Human-in-the-loop Fabrication of 3D Surfaces with Natural Tree Branches

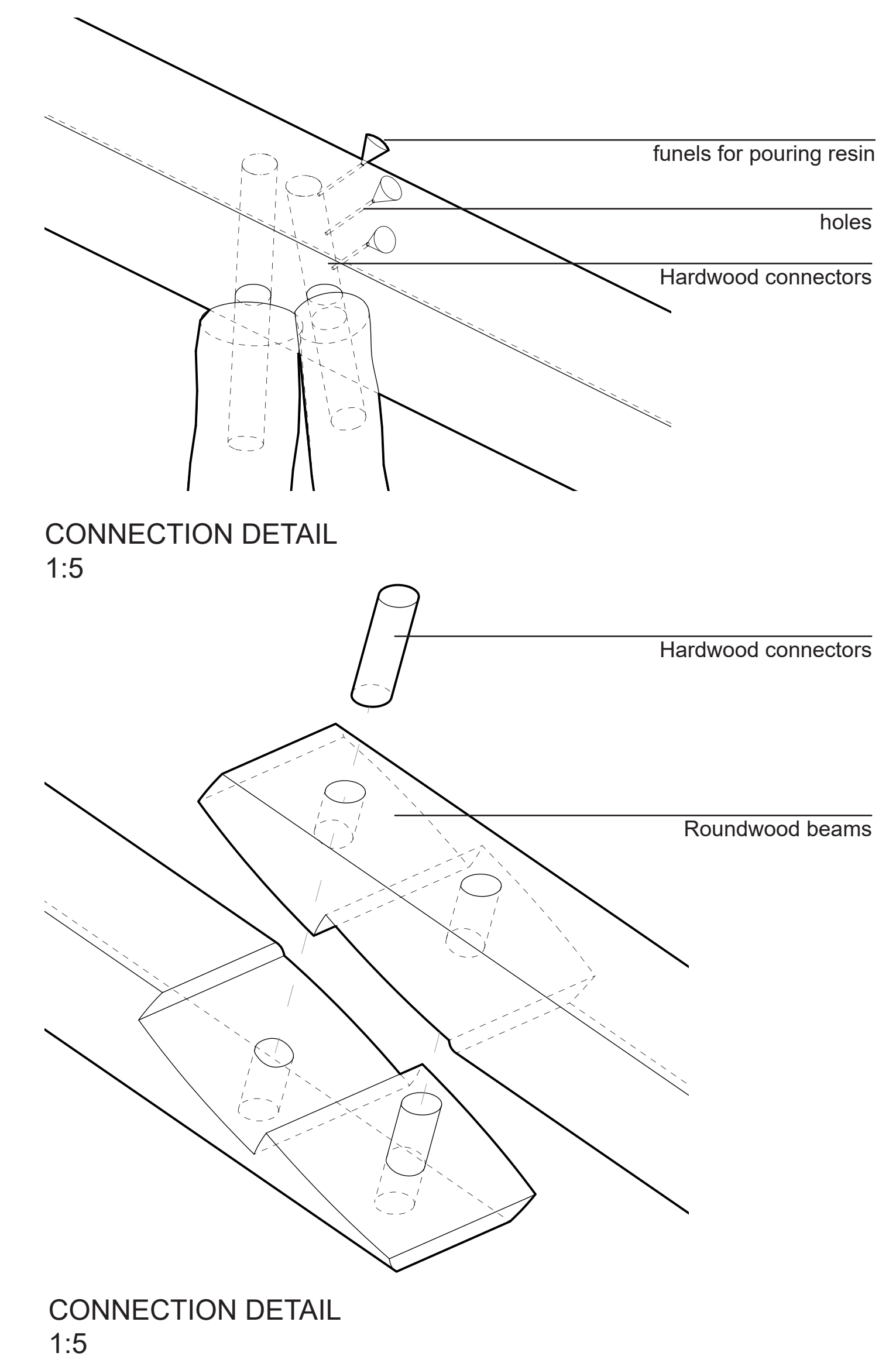
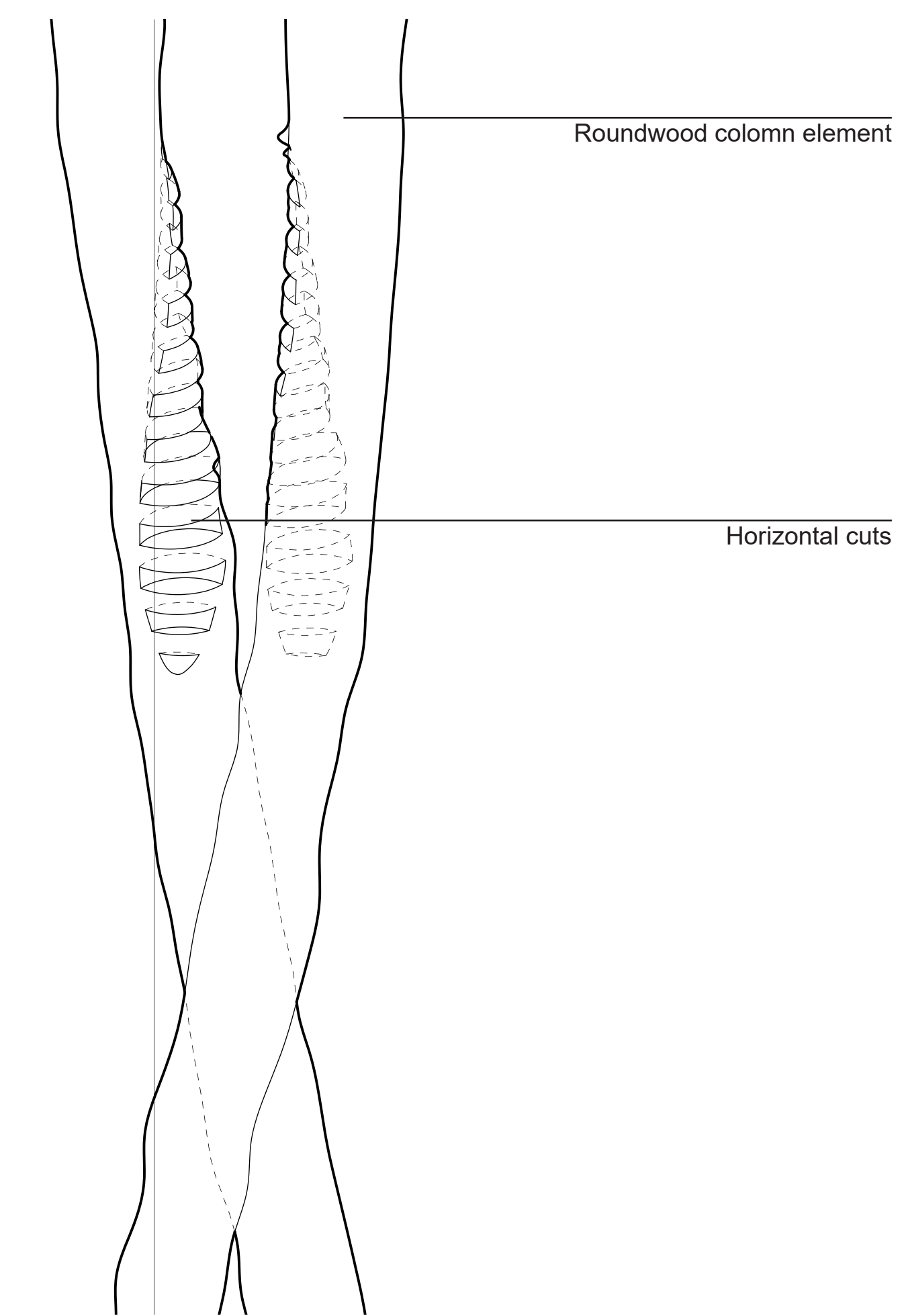
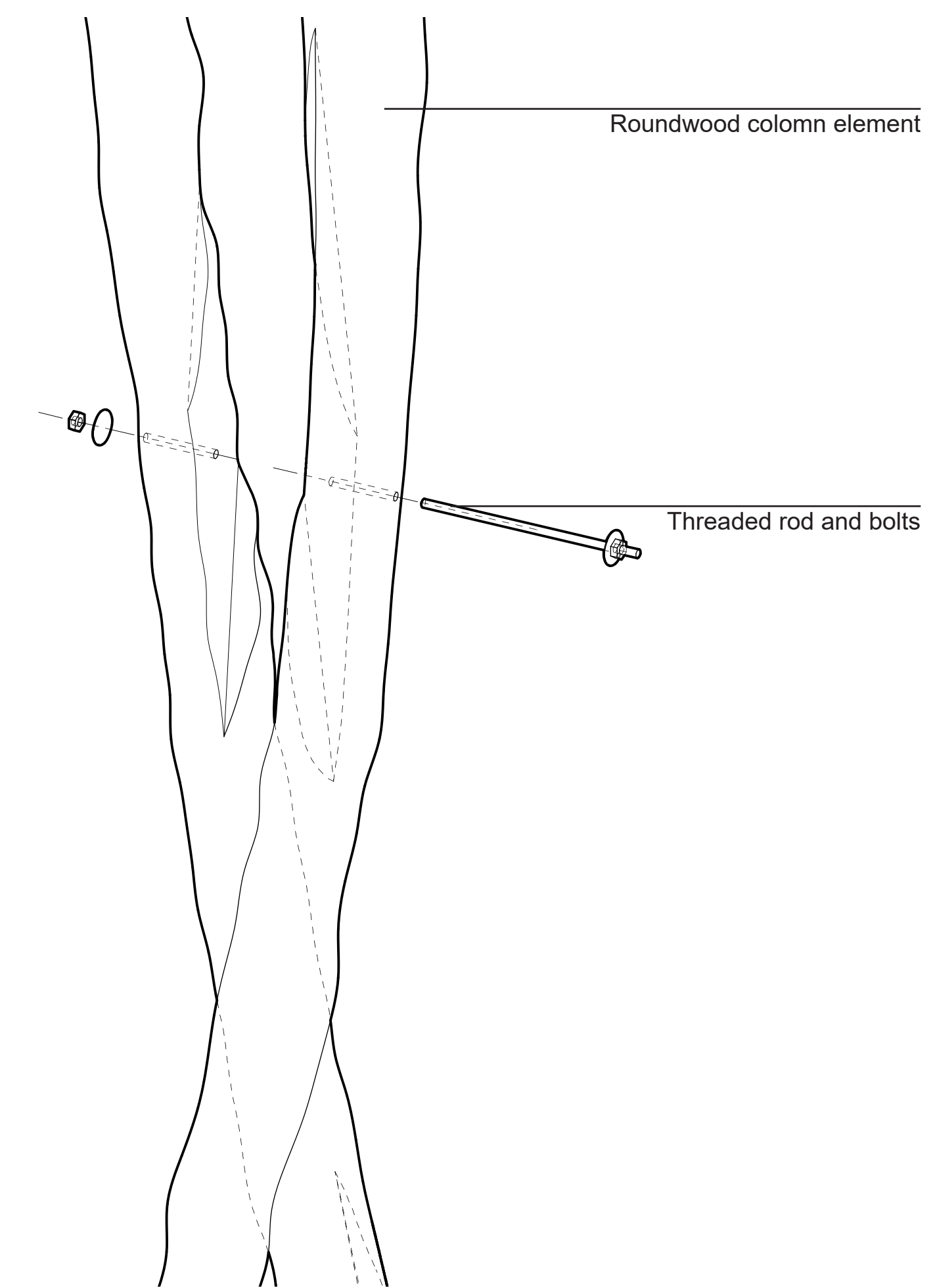
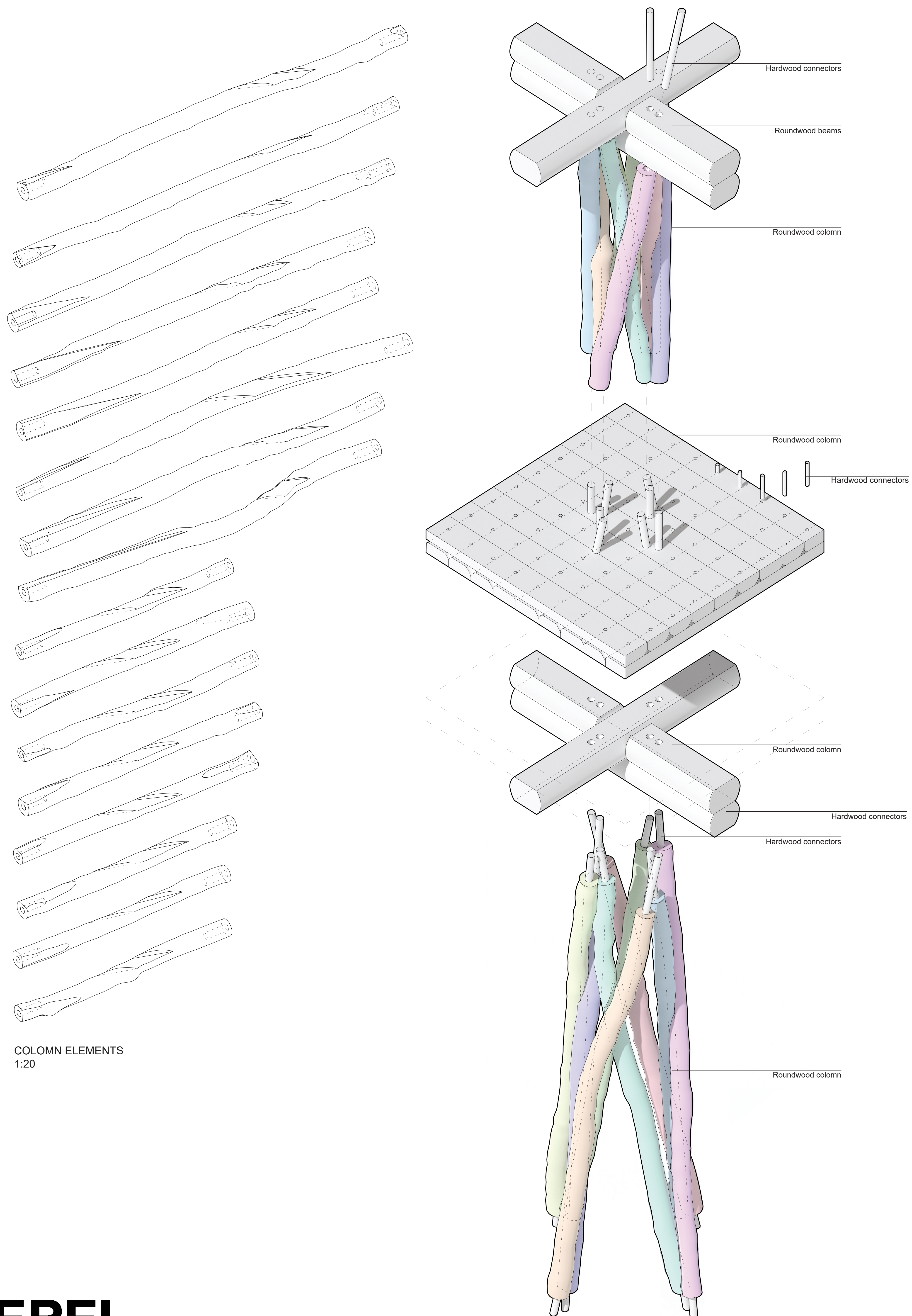
Fig 4.5.10 - Beam assignment from the real to the digital state: a) Hungarian algorithm, b) initial model with equal radii beams, c) oriented scans, d) altered design.

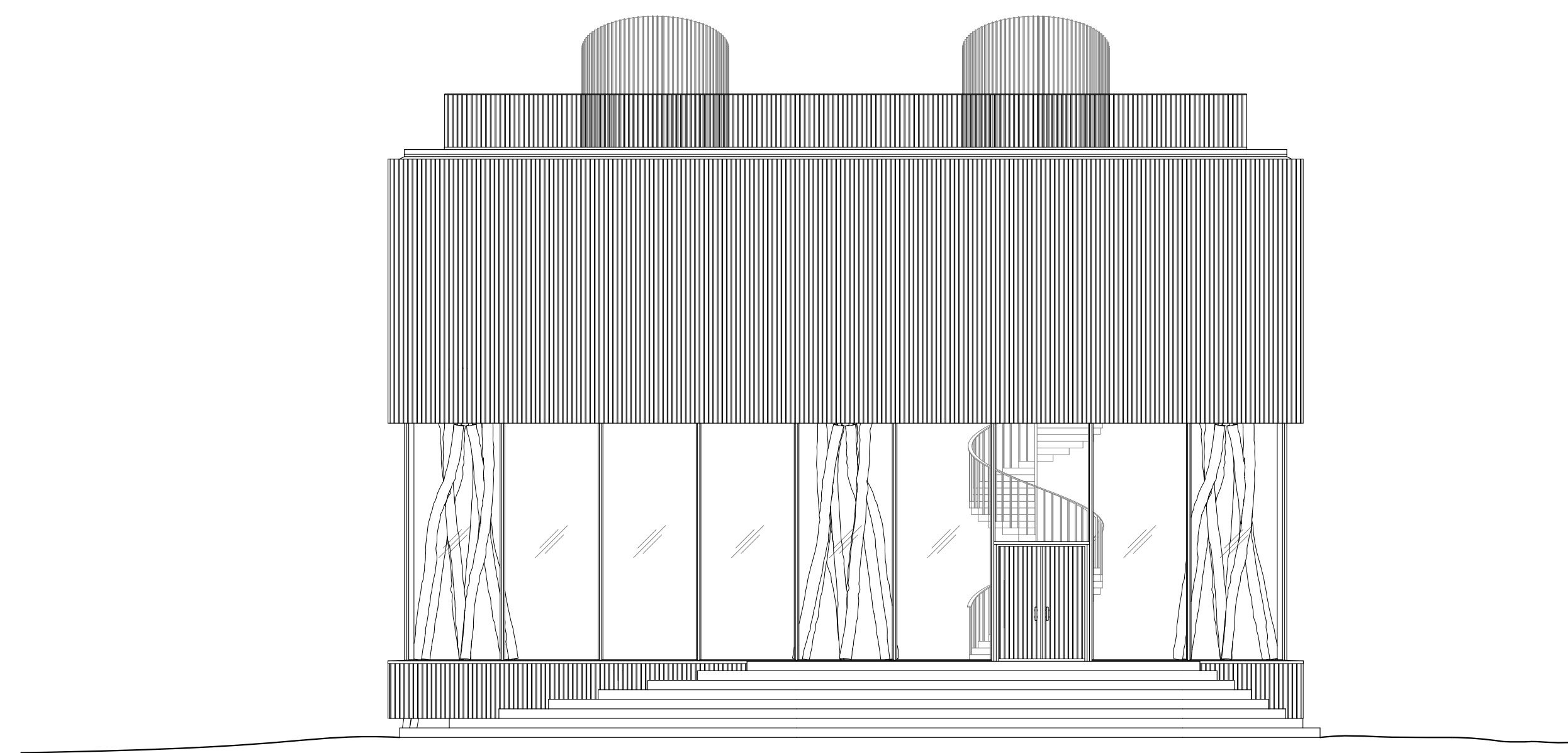
Human-in-the-loop Fabrication of 3D Surfaces with Natural Tree Branches
Authors: Maria Larsson, Hironori Yoshida, Takeo Igarashi
University of Tokyo



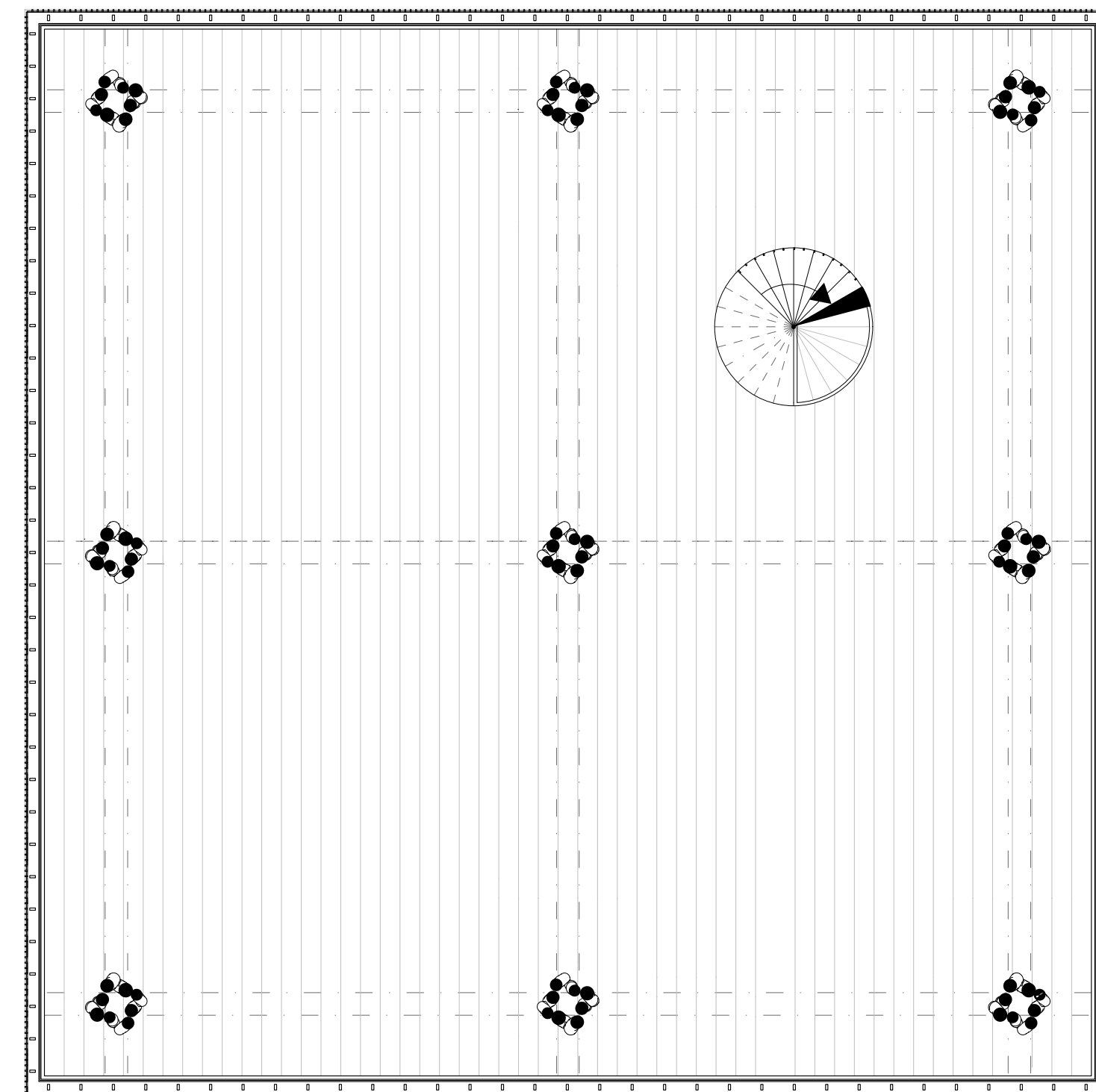
WILD WOOD GRIDSHells
Digital Structures MIT, Prof Caitlin Mueller

**Arthur Billotte & Oskar Forsblom
IBOIS Studio
231219**

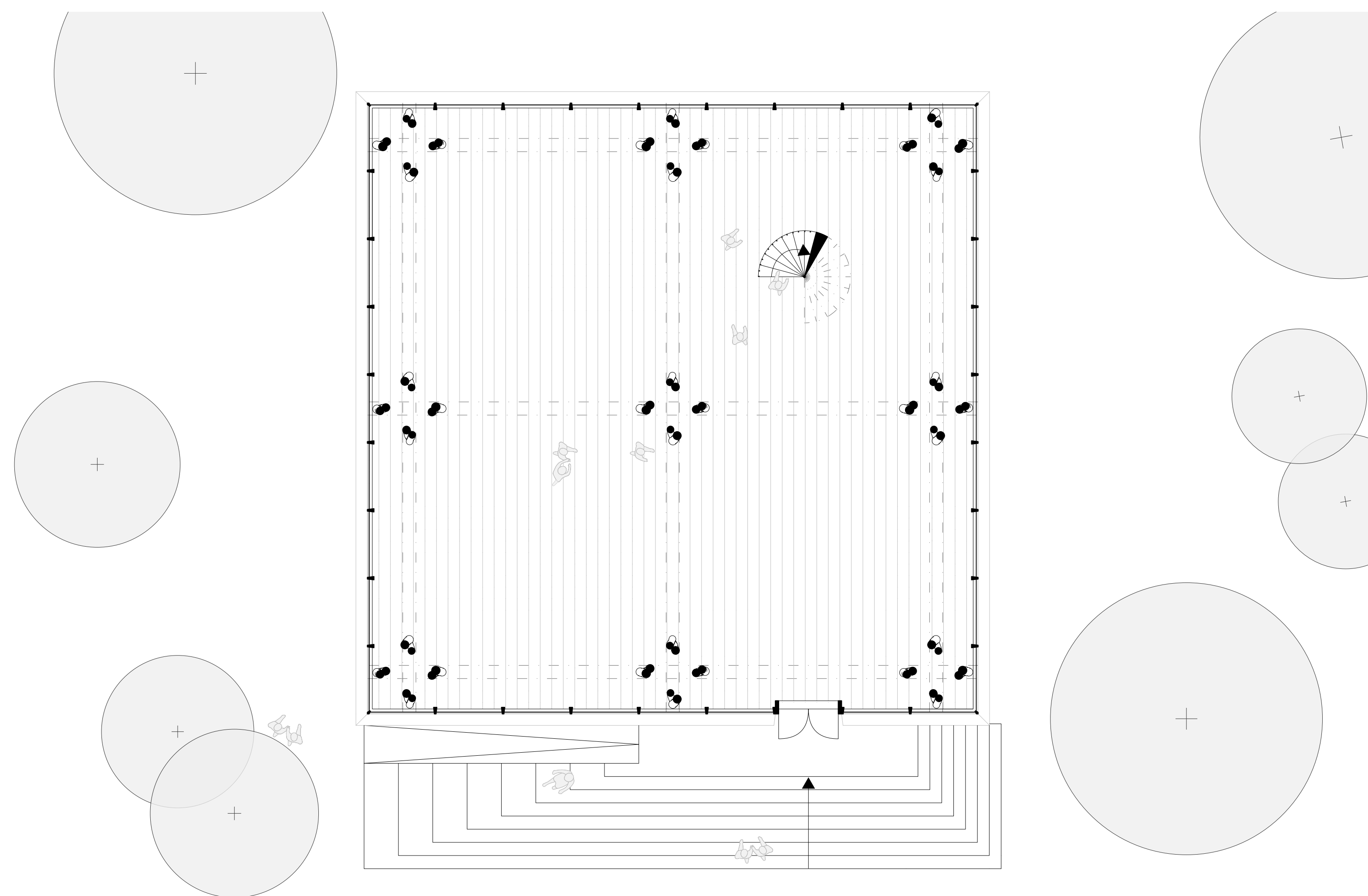




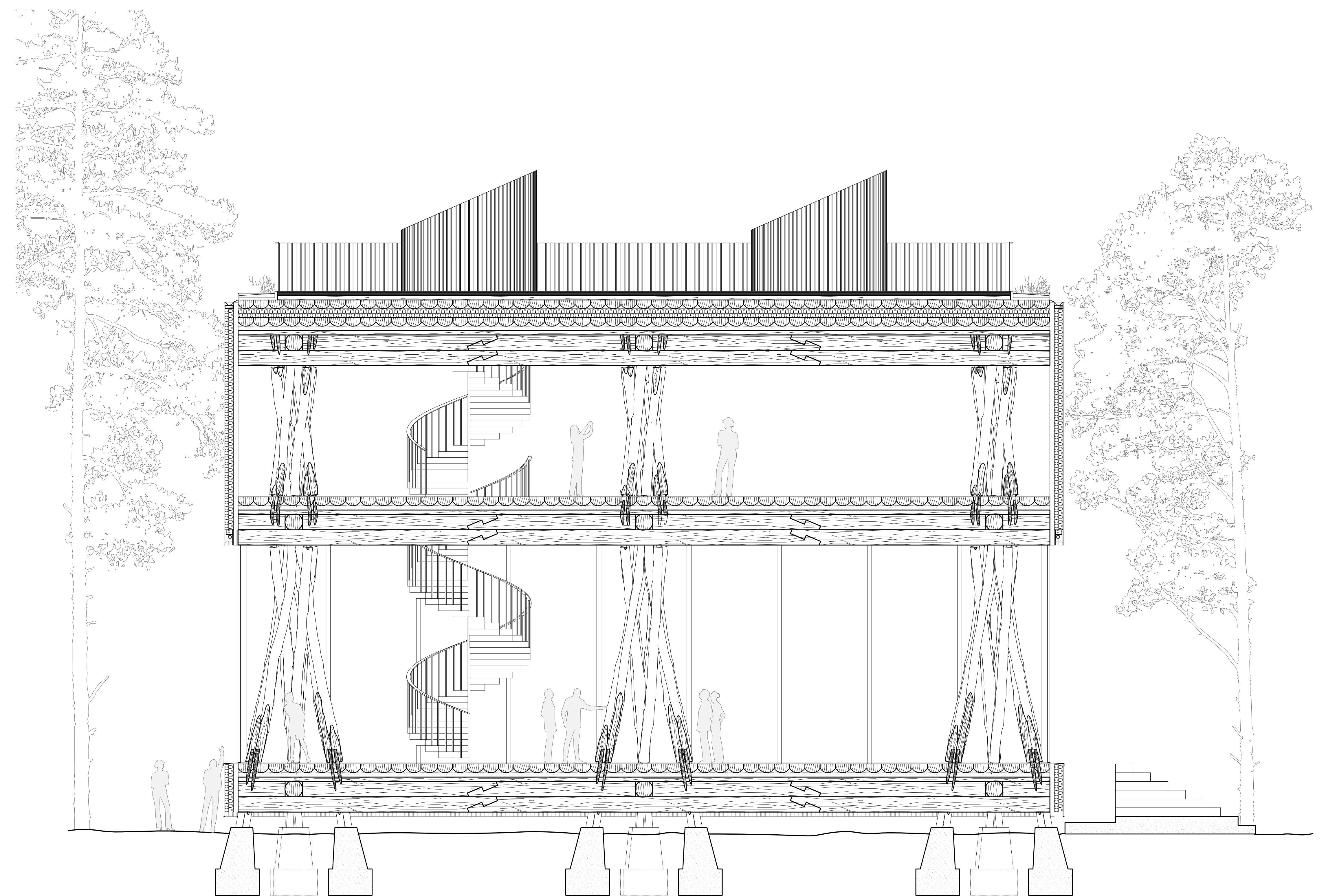
ELEVATION 1:100



FIRST FLOOR 1:100



GROUND FLOOR 1:100



SECTION 1:50

