WORLD BAMBOO CONGRESS 2024
Academic Session - 15:00h - 15:15h, Friday 19 April 2024, Hsinchu, Taiwan

Dr. Ir. Arch KRISTOF CROLLA
Associate Dean (Special Projects), Associate Professor
Founder and Principal, Laboratory for Explorative Architecture & Design Ltd. (LEAD)

Research

WWW.ARCH.HKU.HK

BUILDING SIMPLEXITY LAB

B S L . H K U . H K

Application

Founder & Principal

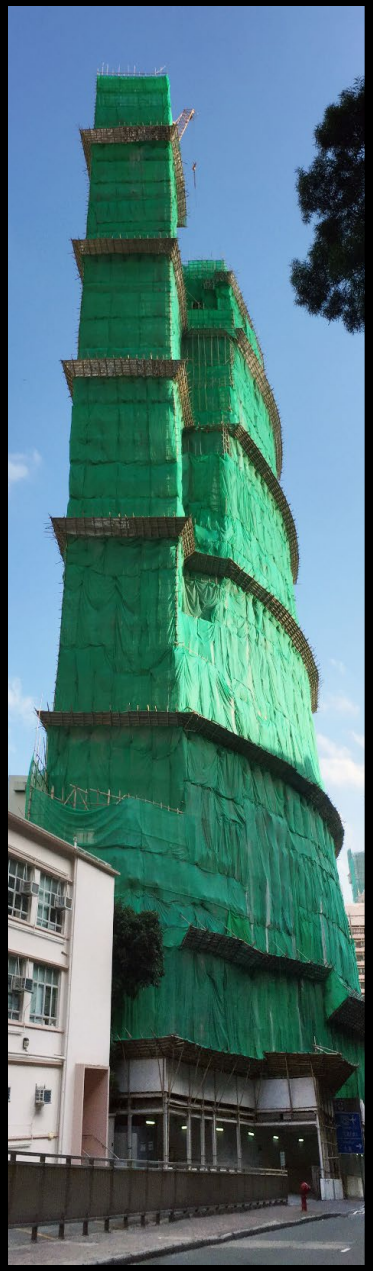
How can XR help with:

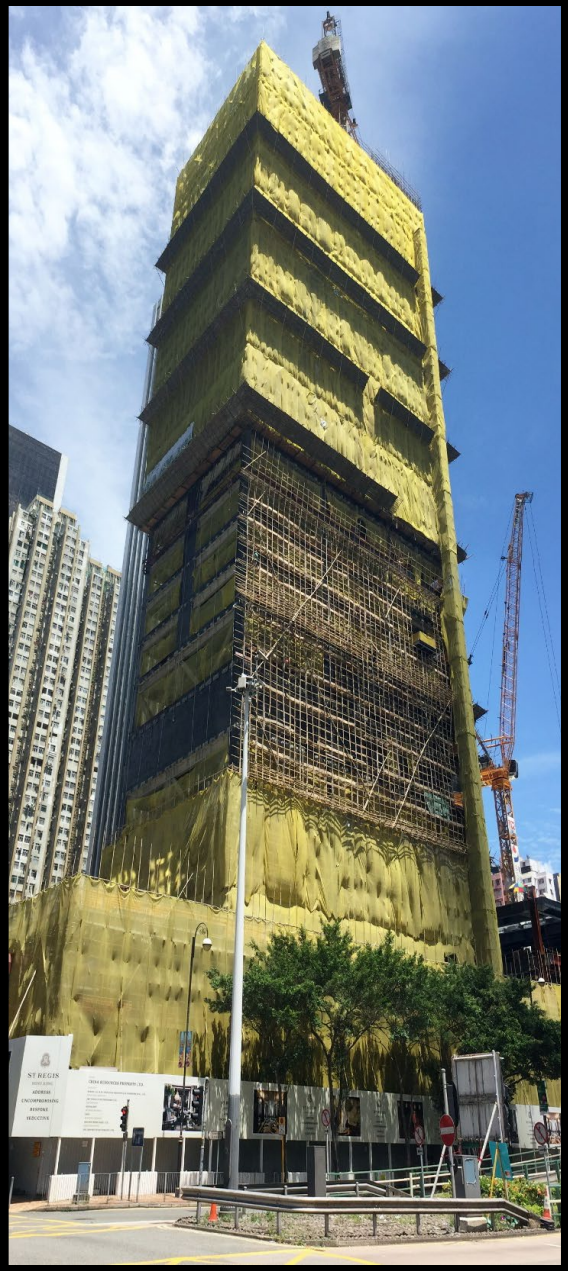
BUILDING SIMPLEXITY

OVERCOMES CONSTRUCTION COMPLEXITIES associated with digital designs through the **SIMPLEST OF MEANS,** using digital design tools as weapons of choice to root the work in a **HUMAN-CENTRED CONSTRUCTION REALITY**.

for Bamboo Architecture

The CUHK project research was partially supported by a grant from the Research Grants Council of the Hong Kong Special Administrative Region China (Project No. CUHK24400114)




ST REGIS


新昌
萬營
大藥房

South China Morning Post

Hong Kong

Tradition of grand bamboo theatres may disappear, architect warns

The skills of the craftsmen who assemble the structures must be preserved, an architect says

Vivienne Chow + myNEWS

Published: 12:00am, 15 Jan, 2013

The Bamboo Theatre at the West Kowloon Cultural District slowly takes shape. The festival begins at the end of the month and runs until February 16. Photo: Edward Wong

rthk.hk 香港電台網站

Time for HK to ban bamboo scaffolding: engineer

2024-02-21 HKT 16:33

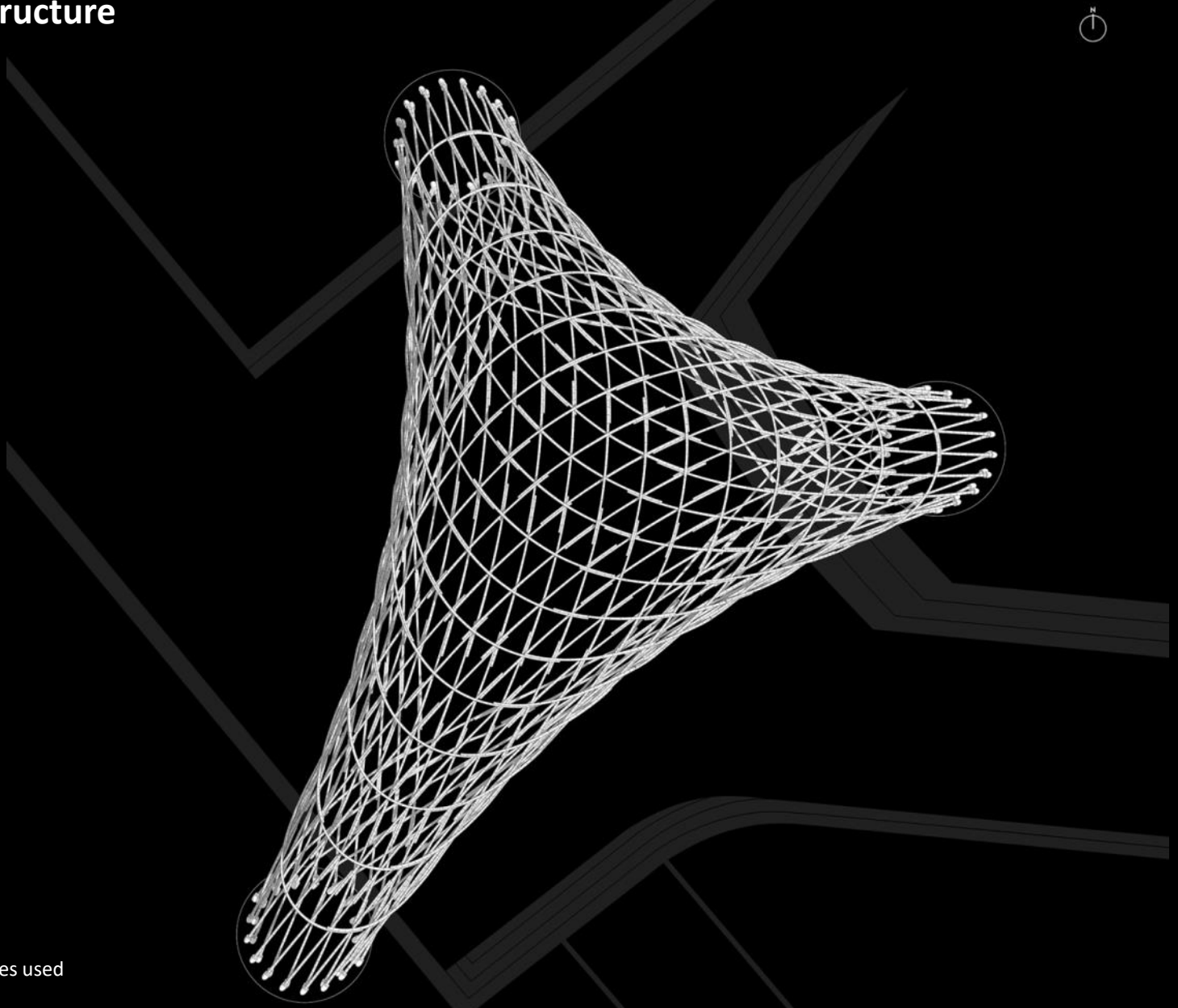
An engineer says it's not that easy to assess the safety of bamboo scaffolding. Image: Shutterstock

Hong Kong should ban the use of bamboo scaffolding in light of this week's deadly collapse, the chairman of a Hong Kong Institution of Engineers (HKIE) safety panel said on Wednesday.

CLIENT BRIEF

- Host public events
- Showcase bamboo potential
- Promote sustainability

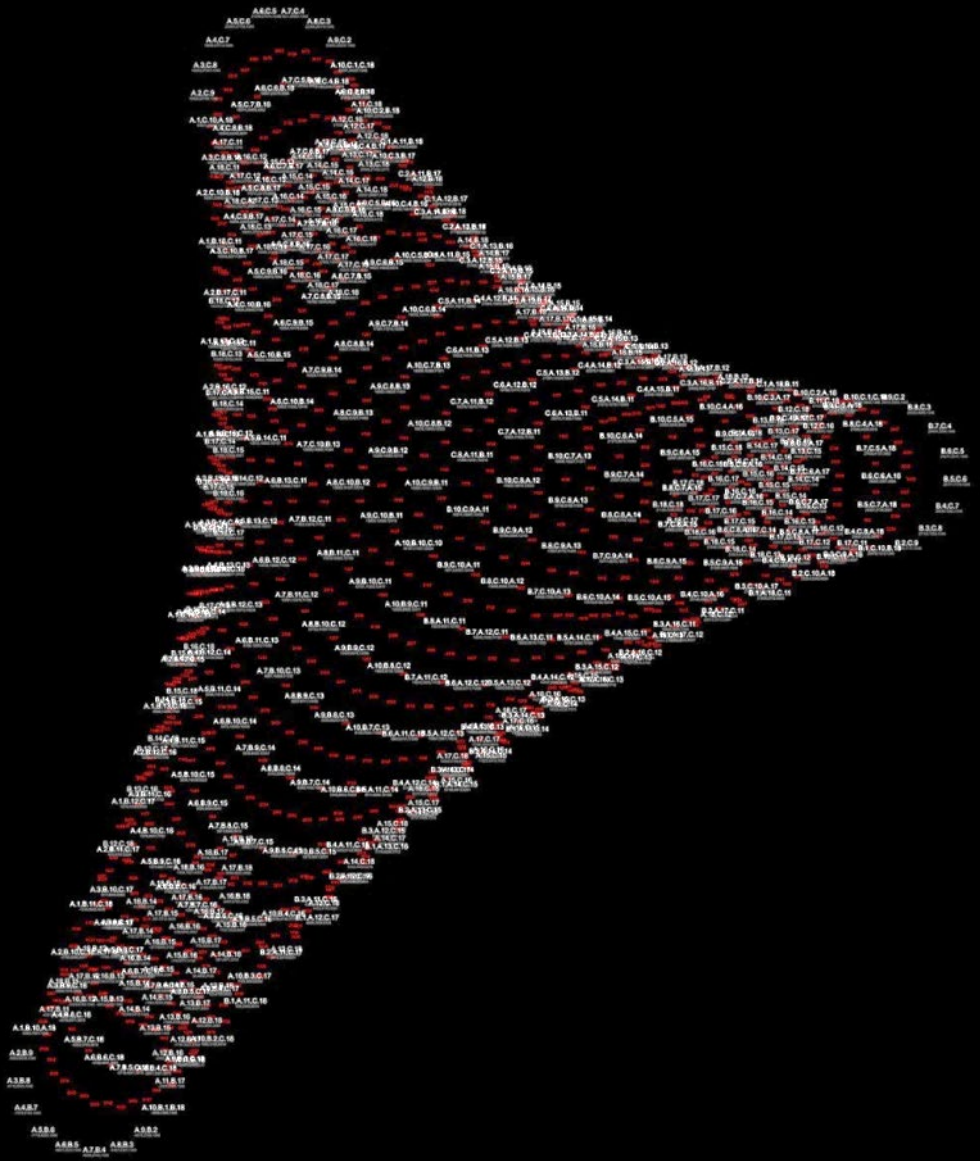
Bamboo Substructure



Total #:	473 poles used
Total Length:	2956m
Pole ø:	base: 12-15cm, top: 8-12cm
Pole length:	≈ 7.2m
Total weight:	6,350kg (7,100kg in wet state)

Bamboo Substructure

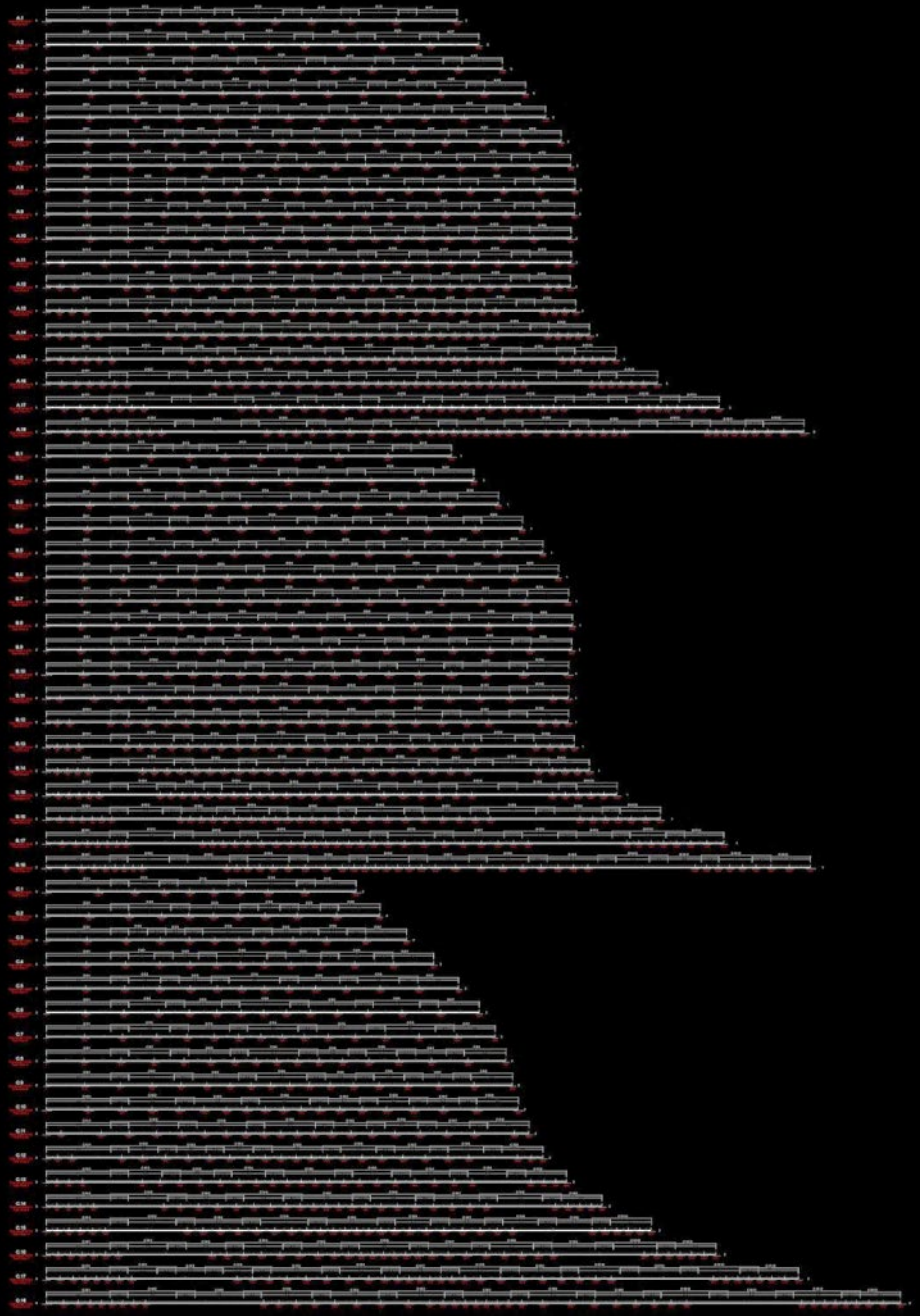
Annotation



Ties:	galvanized metal wire
# intersections:	1107
# overlaps:	365 (3 ties per overlap)
total # ties:	3321

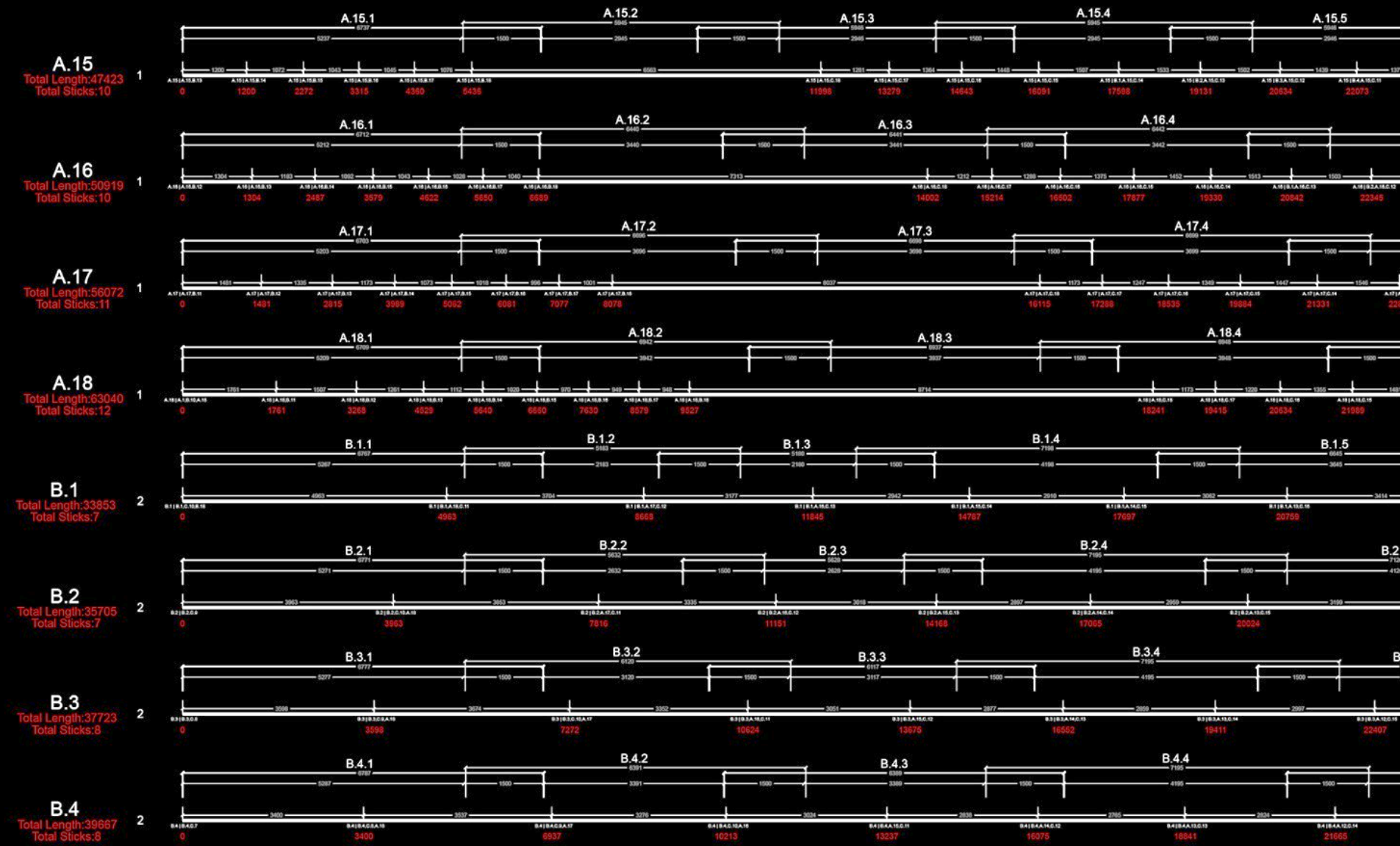
Bamboo Substructure

Annotation



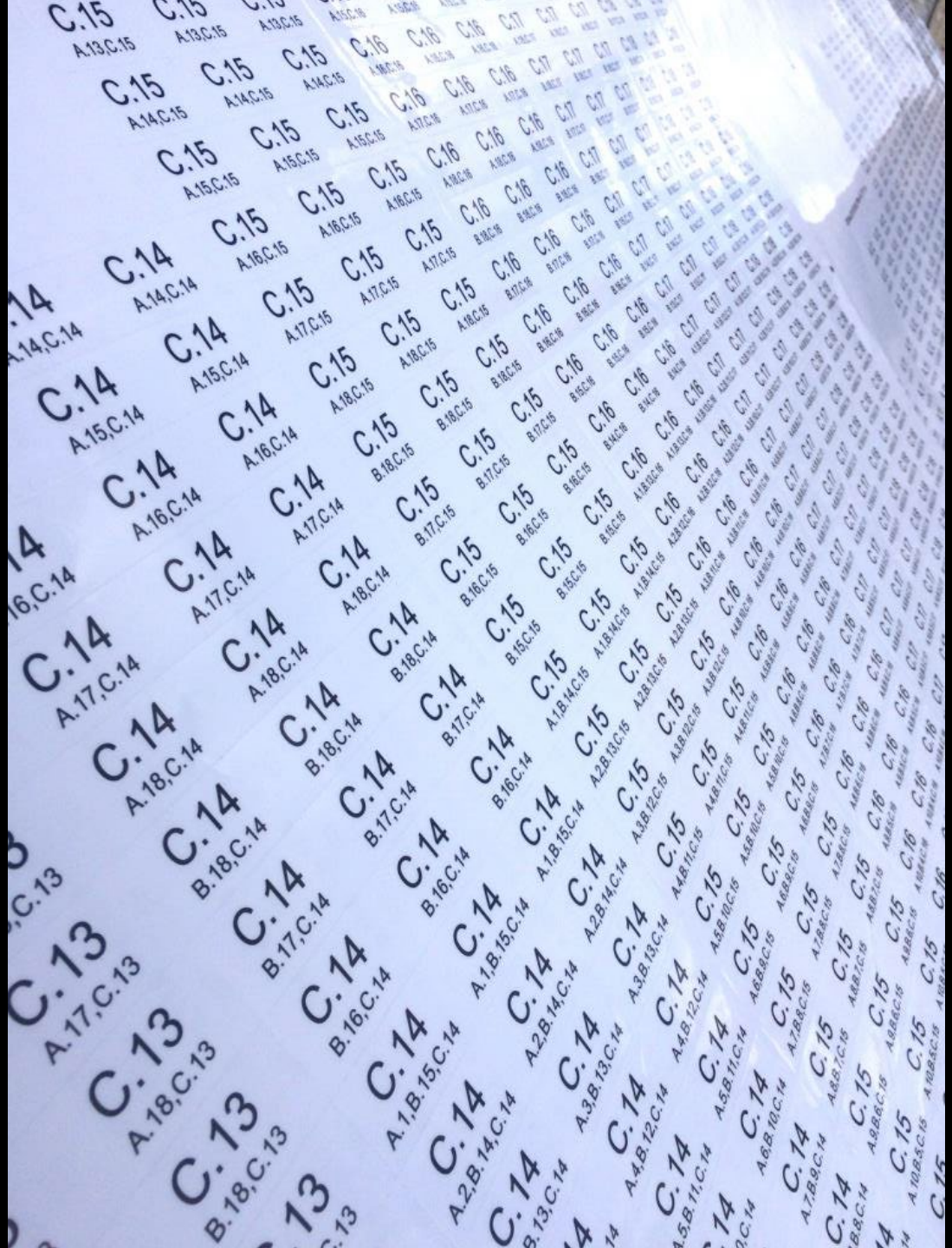
Bamboo Substructure

Annotation



Bamboo

Annotation



Bamboo

Annotation

Bamboo Substructure

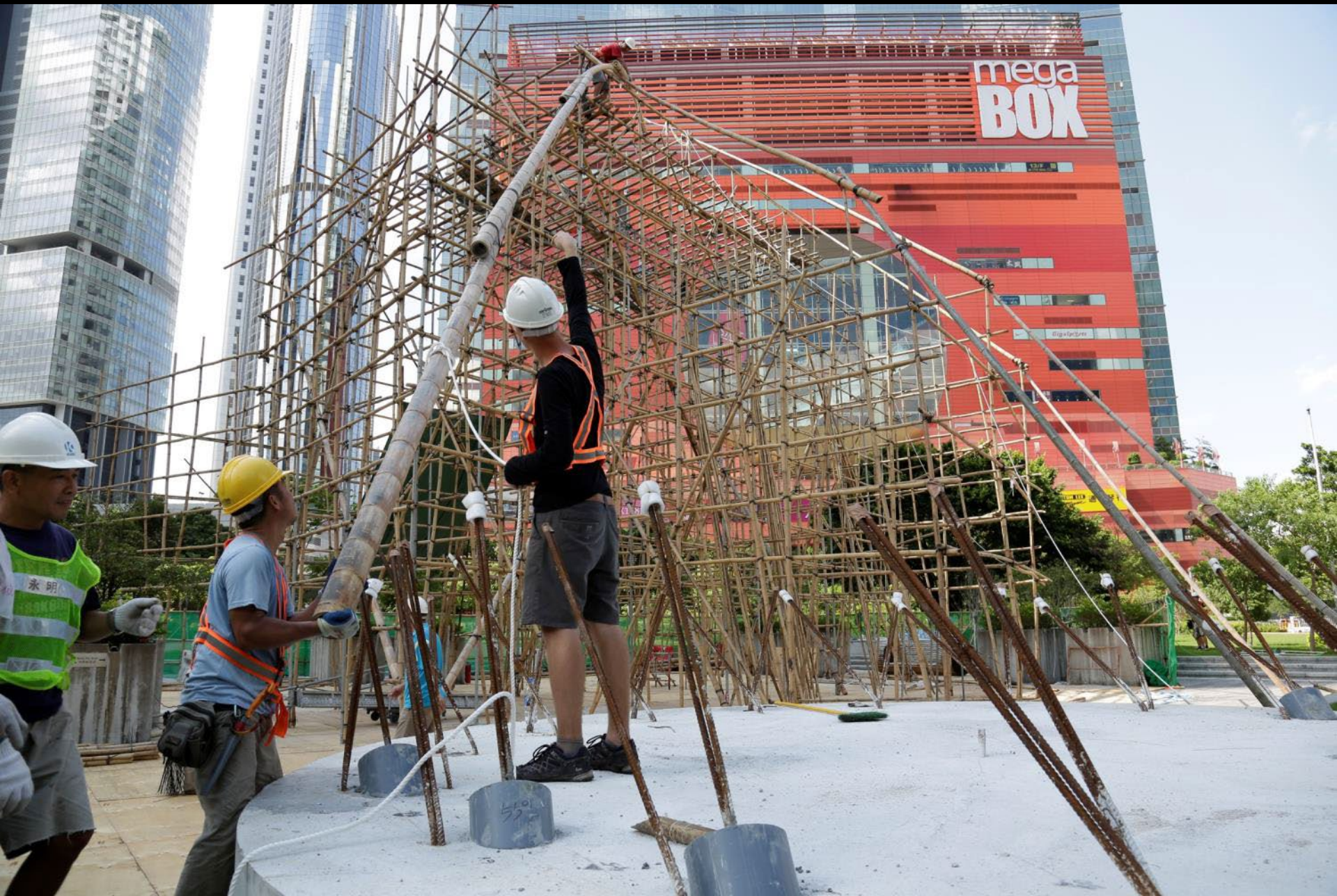
Annotation

Bamboo Substructure

Annotation

Pole Installation

1st pole installation



Interconnection Ties

Installation in Segments

Interconnection Ties

Installation in Segments

Bamboo Structure

Completed

Membrane

Installation Attempt 2

Membrane

Fixing to Substructure

Events

CUHK Opening Reception

WORLD ARCHITECTURE FESTIVAL
Small Project of the Year

G-MARK
Tokyo, Japan
GOOD DESIGN BEST 100

2016 GOLDEN PIN DESIGN AWARD
Taiwan Design Centre
Spatial Design

HONG KONG DESIGN AWARDS
Pop up, Display, Exhibit & Set Design
GOLD AWARD

ARCHITIZER
Architecture + Wood
JURY WINNER

ARCHITIZER
Architecture + Engineering
POPULAR CHOICE

ARCHITIZER
Architecture + Sustainability
FINALIST

ARCHITIZER
Cultural: Pavilions
SPECIAL MENTION

A&D TROPHY AWARD
Architecture & Design
Green or Sustainable
BEST OF

INTERNATIONAL PROPERTY AWARDS
☆ ☆ ☆ ☆ ☆
BEST LEASURE

GREEN BUILDING AWARDS AWARD
Research and Planning
MERIT AWARD

SUCCESSFUL DESIGN AWARDS
SPACE category
MOST SUCCESSFUL DESIGN AWARD

DESIGN FOR ASIA AWARDS
Hong Kong Design Centre
SILVER AWARD

HKDA GLOBAL DESIGN AWARDS
Hospitality & Entertainment Space
GOLD AWARD

HKDA GLOBAL DESIGN AWARDS
Hospitality & Entertainment Space
JUDGES' CHOICE

HKDA GLOBAL DESIGN AWARDS
Hospitality & Entertainment Space
HONG KONG BEST

HoloLens 2
Microsoft

Mixed-reality driven remote teaching and learning

https://www.androidauthority.com/microsoft-hololens-2-958882

iPhone 12 Pro

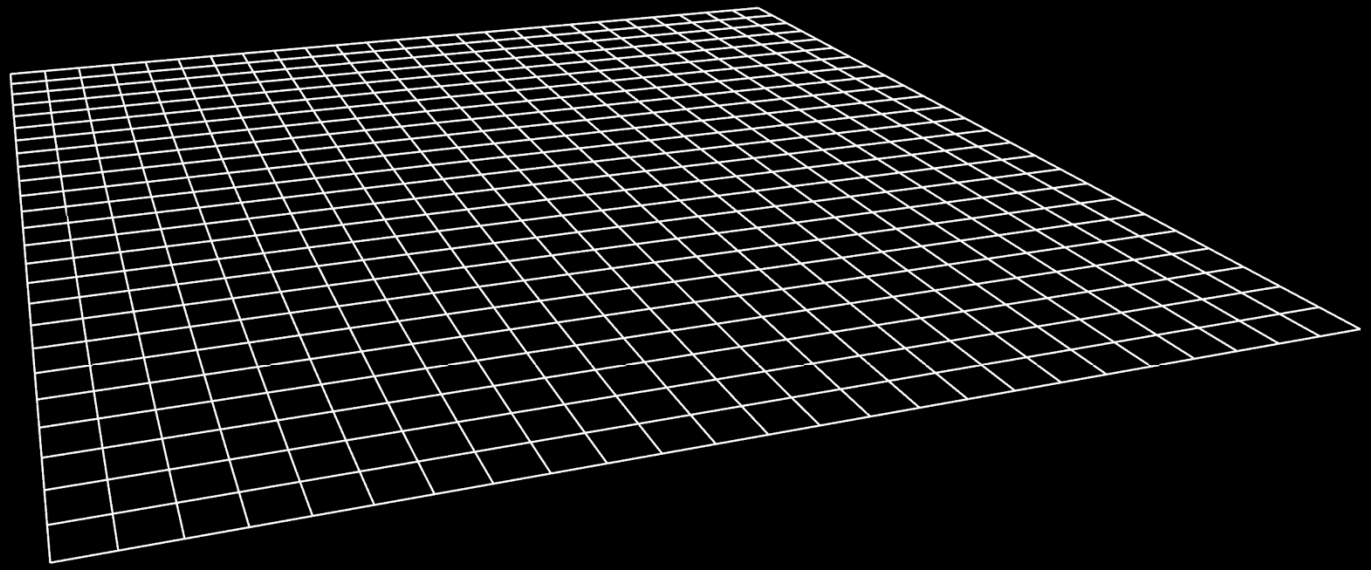
LiDAR Scanner added for “Instant AR” & Depth Mapping

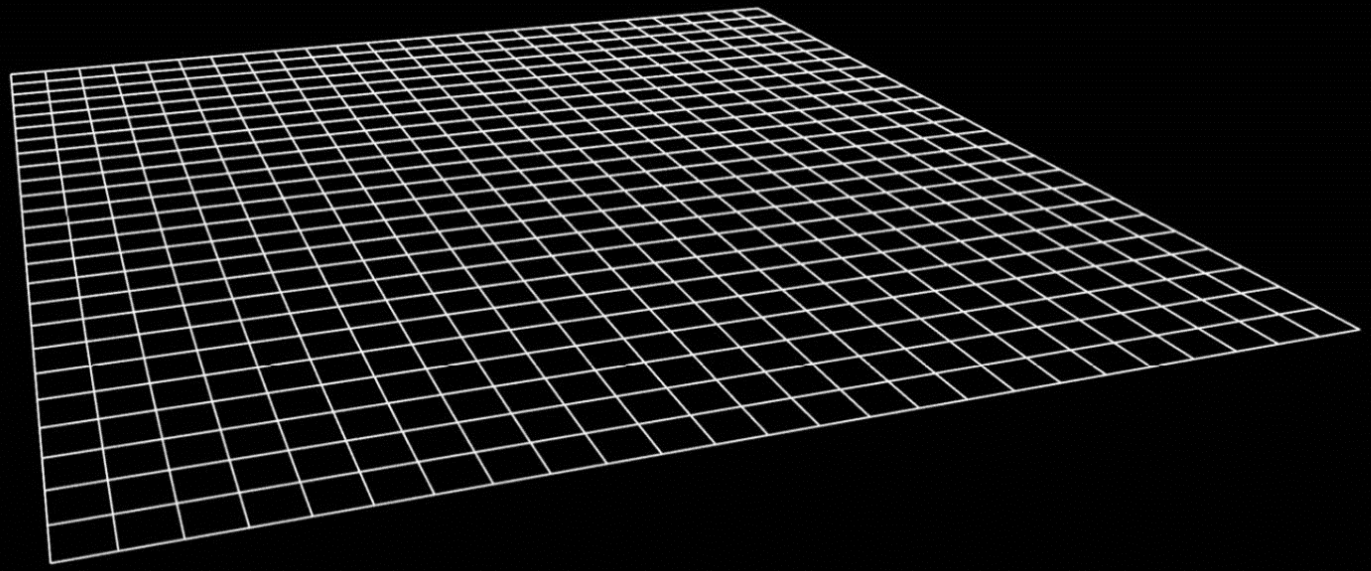
Hidden Side™
LEGO®

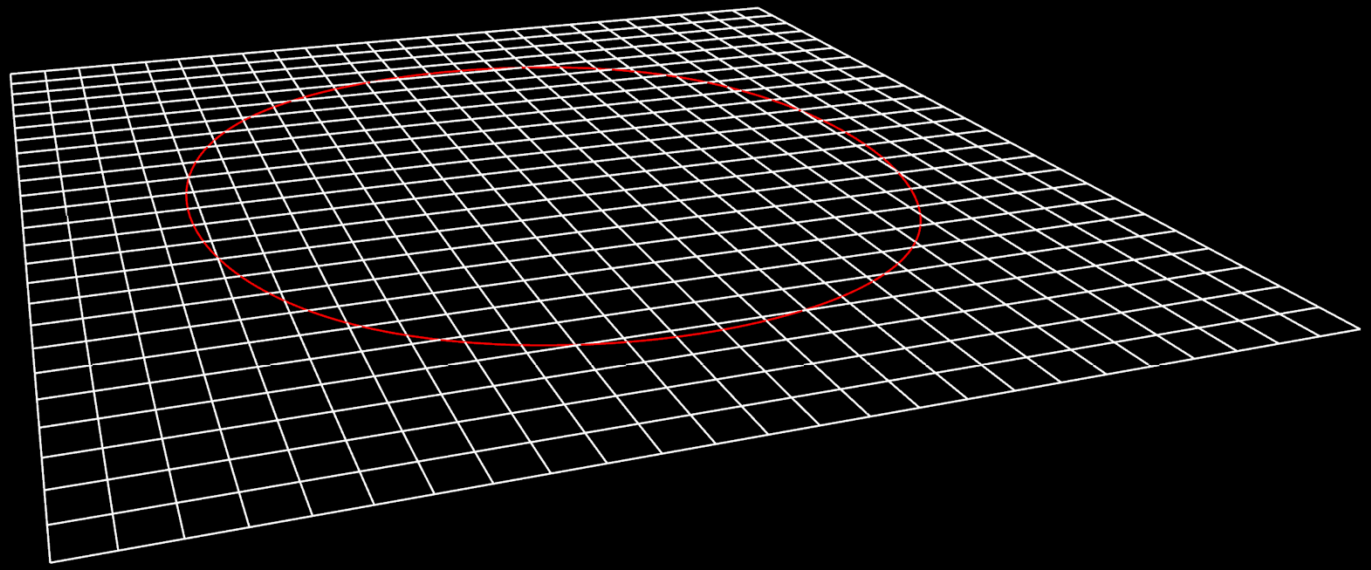
IKEA Place
For iOS11 devices

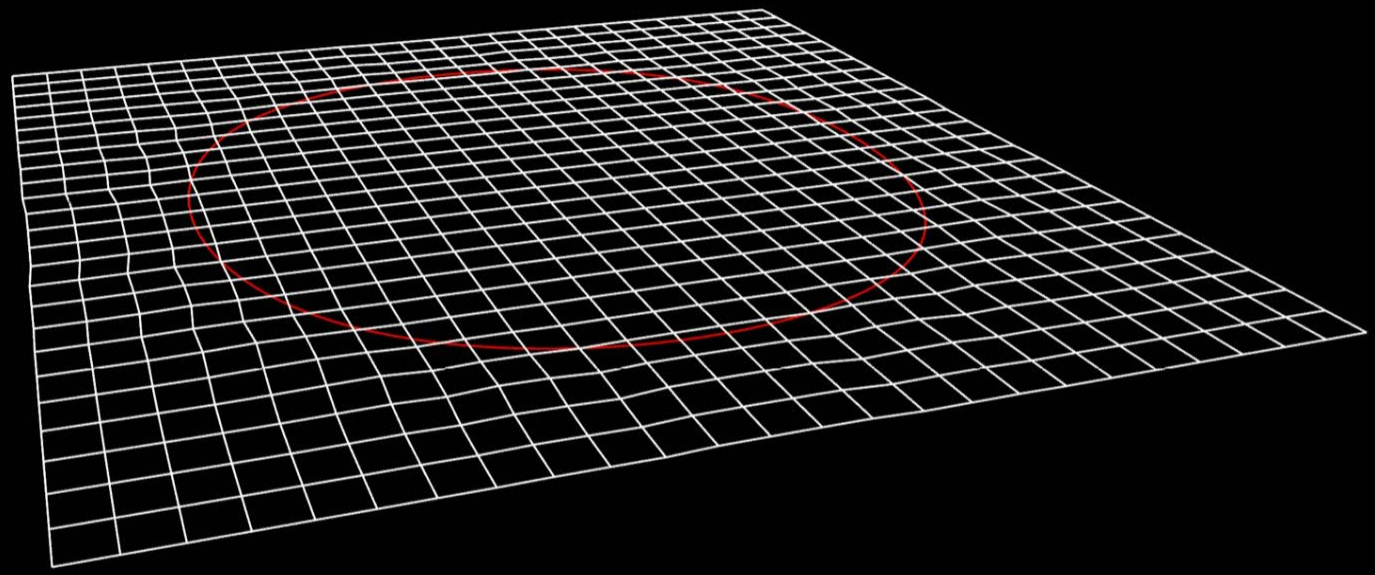
Frei Otto
1925 - 2015

Image source: https://www.domusweb.it/it/notizie/2015/03/11/2015_pritzker_architecture_prize_frei_otto.html









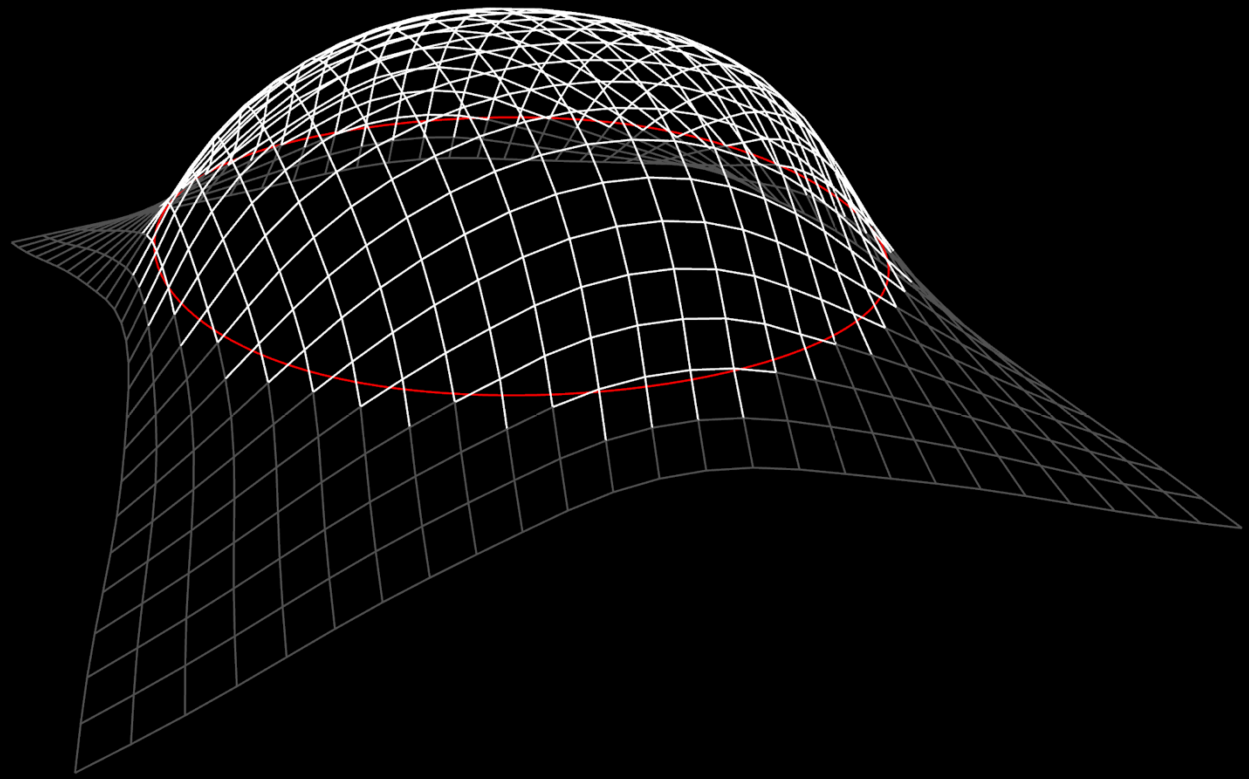
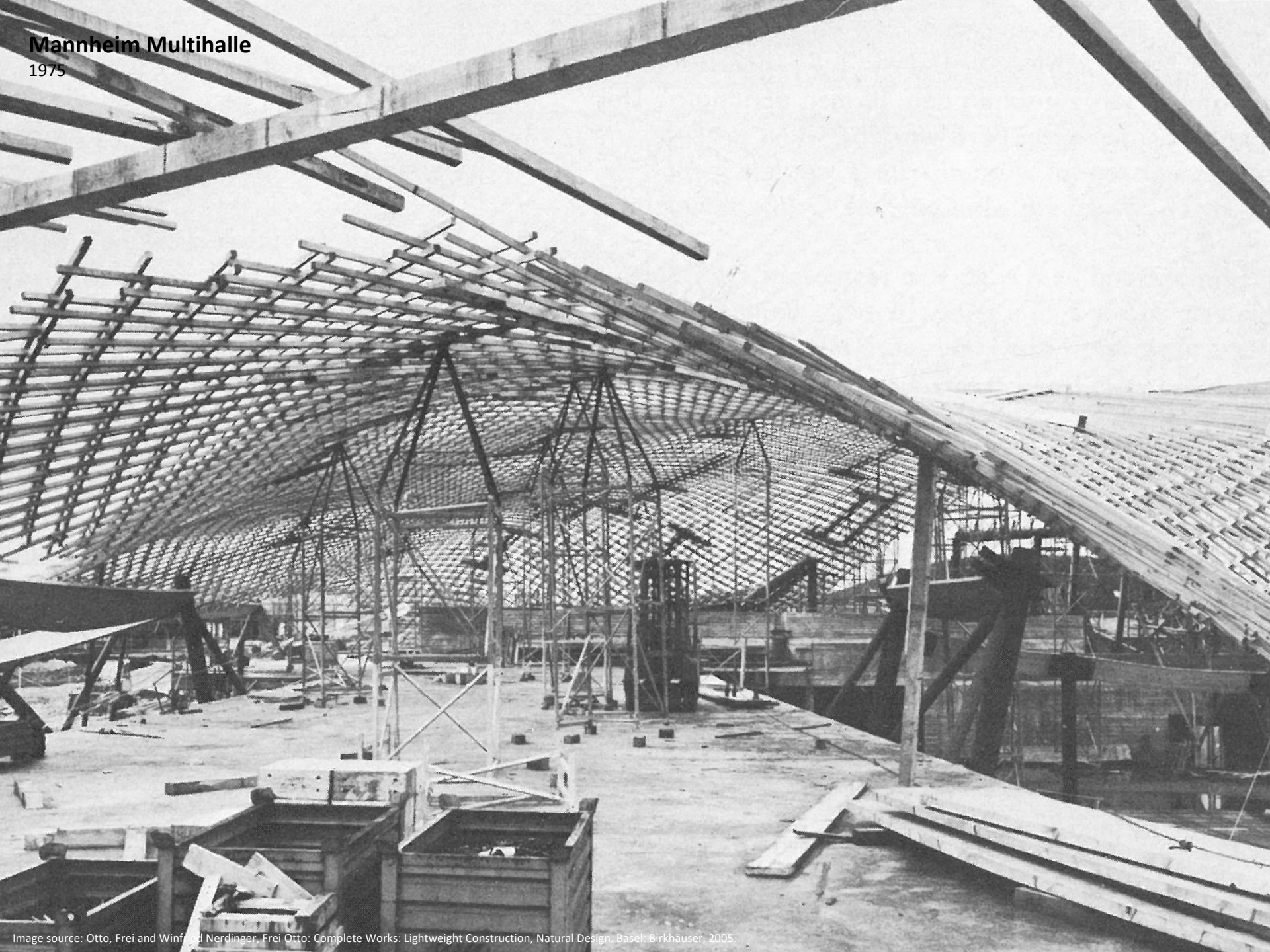


Image source: Otto, Frei and Winfried Nerdinger, Frei Otto: Complete Works: Lightweight Construction, Natural Design. Basel: Birkhäuser, 2005.

Mannheim Multihalle
1975



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Mannheim Multihalle
1975

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Mannheim Multihalle
1975

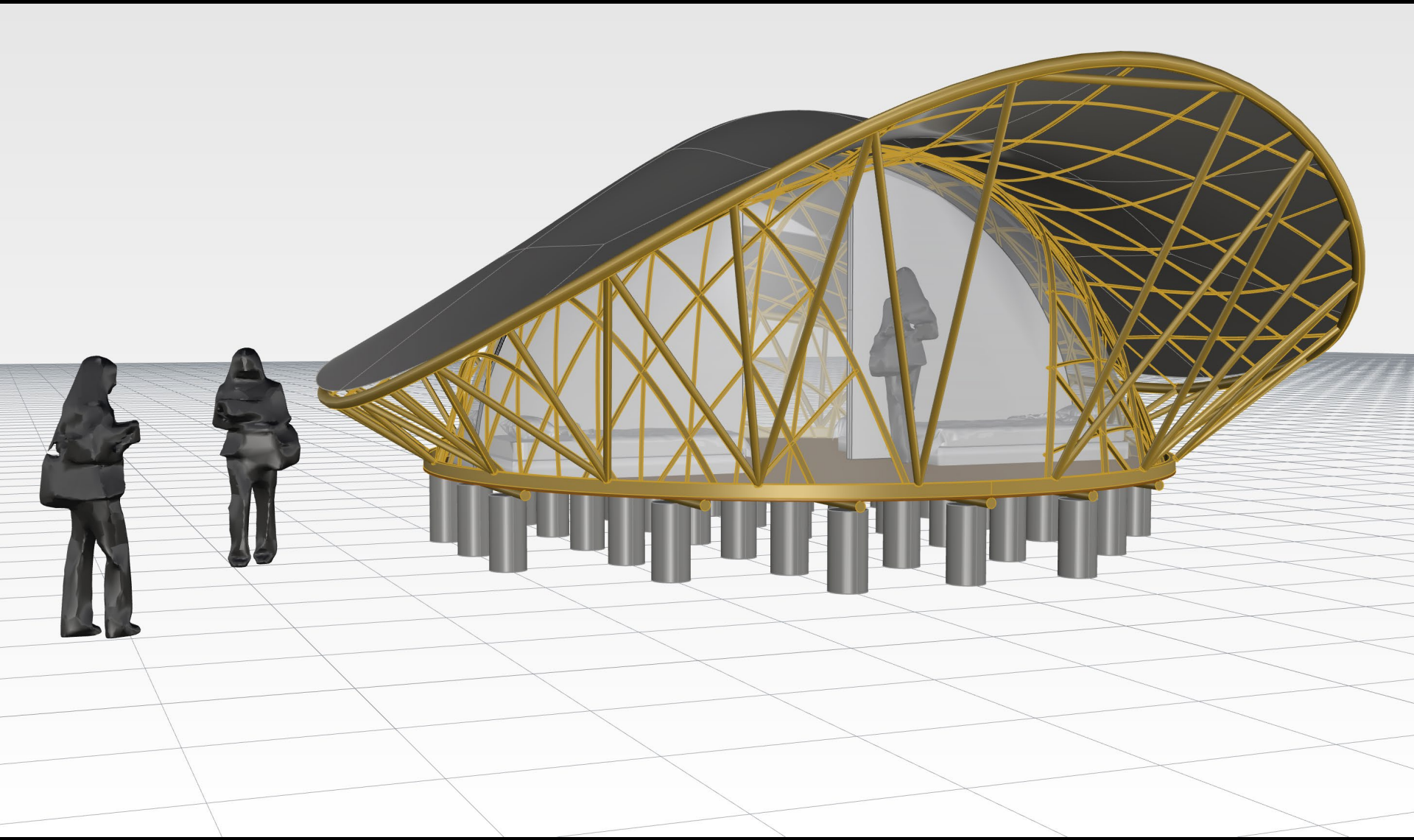
BAMBOO U

11 Day Build & Design Course
on-site in Bali, Indonesia
March 2023

www.bamboou.com

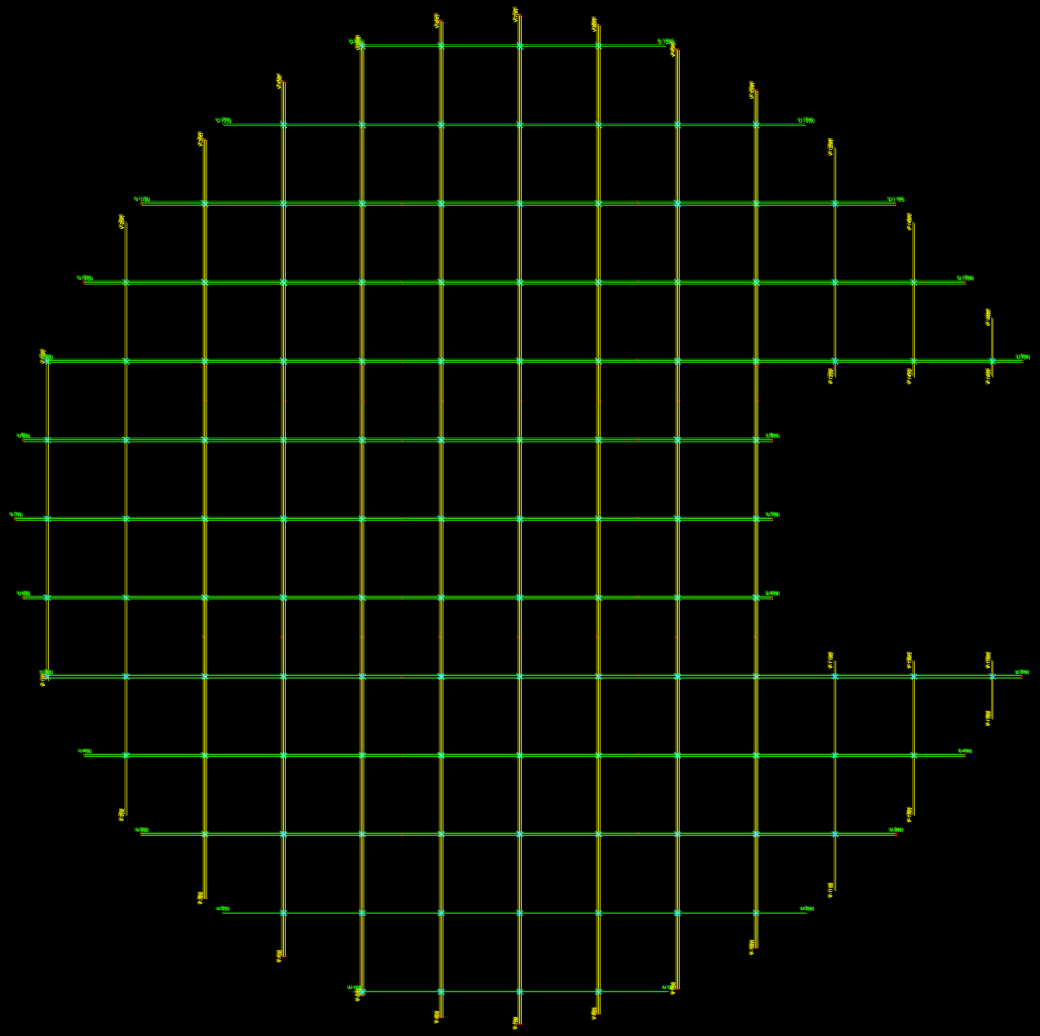
KEPITING BAMBU
Design

x2



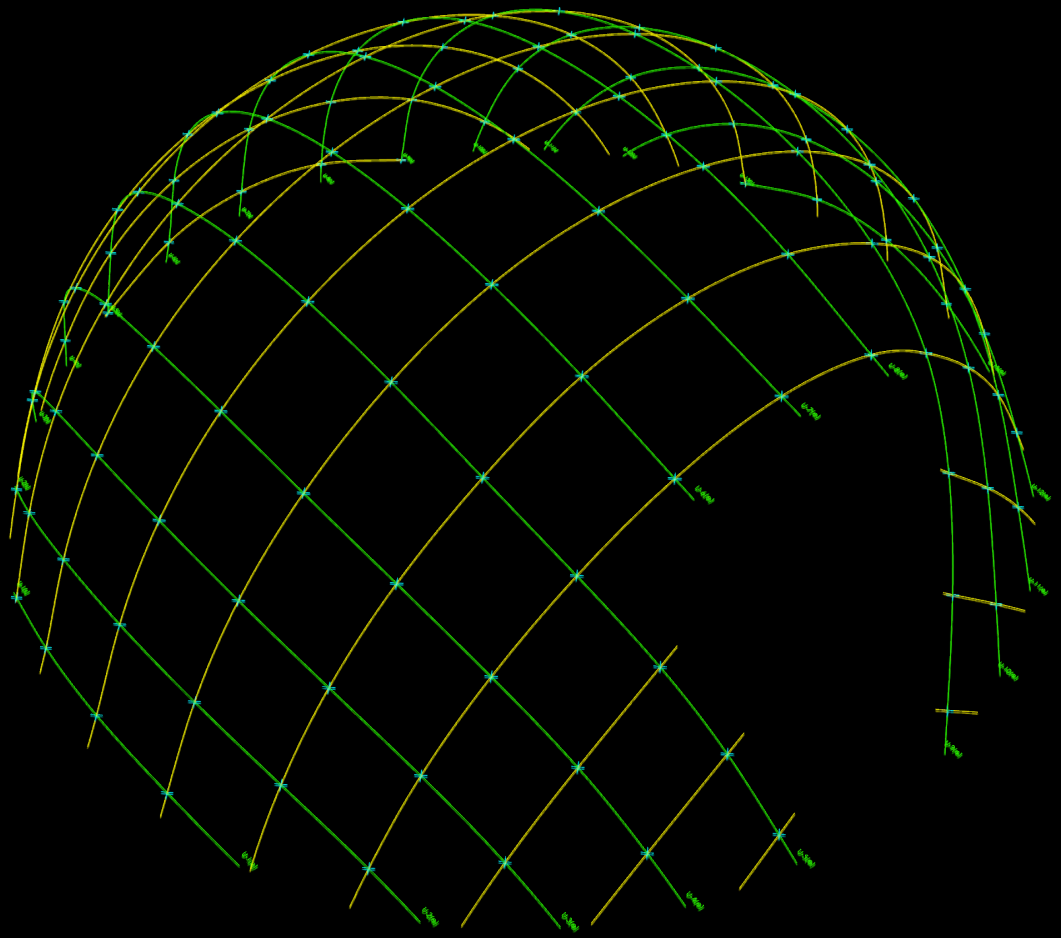
KEPITING BAMBU
Construction sequence

x2



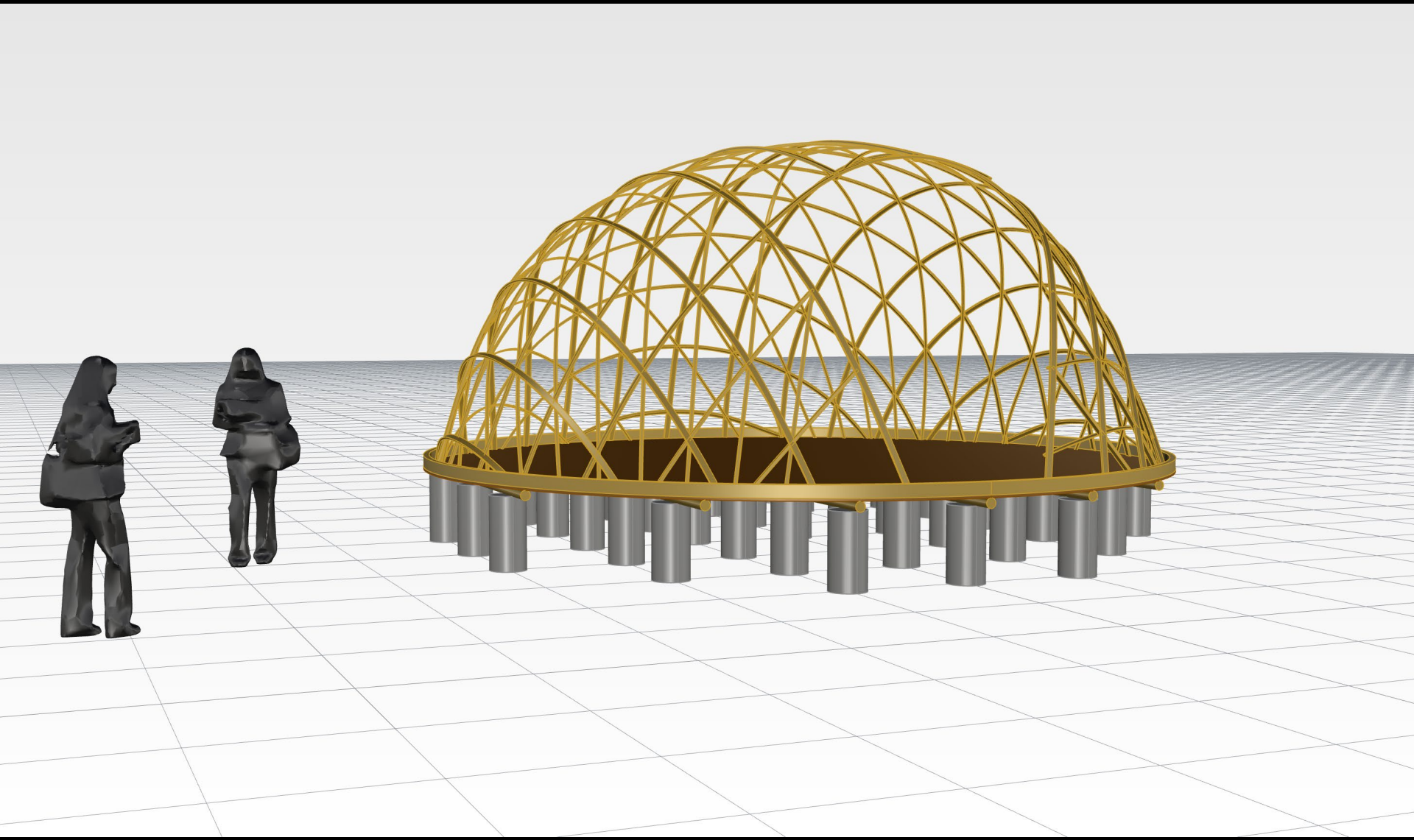
KEPITING BAMBU
Construction sequence

x2



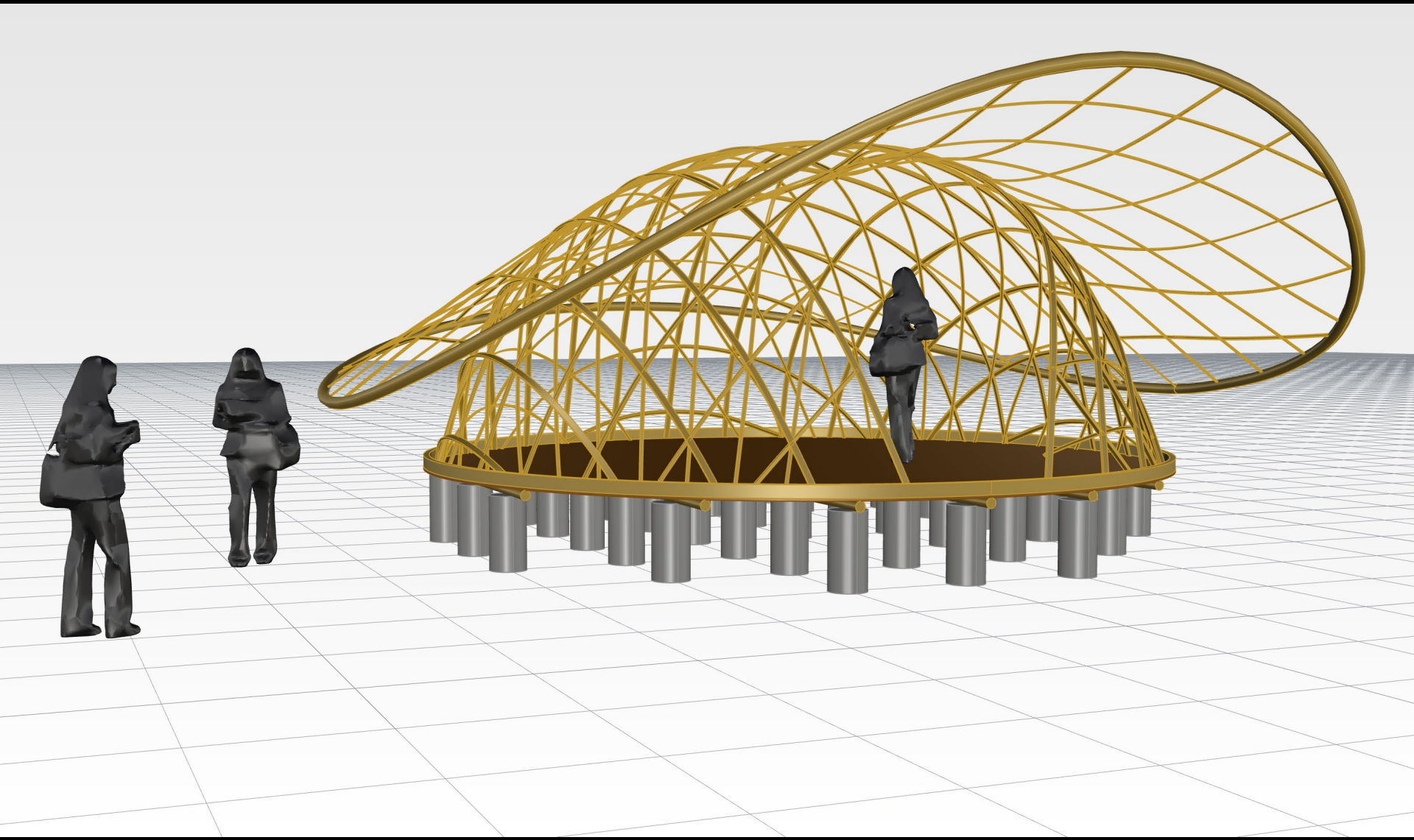
KEPITING BAMBU
Construction sequence

x2



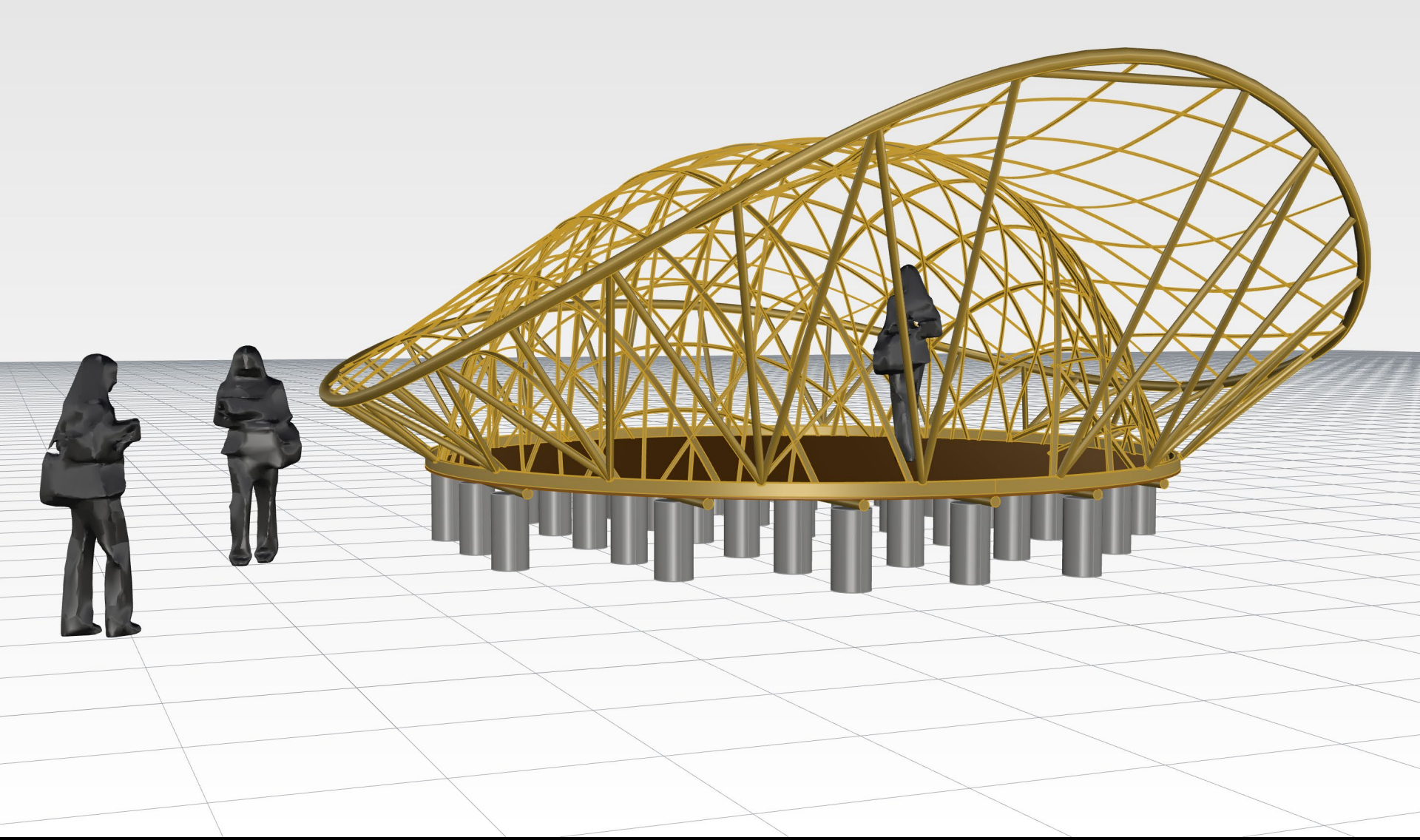
KEPITING BAMBU
Construction sequence

x2



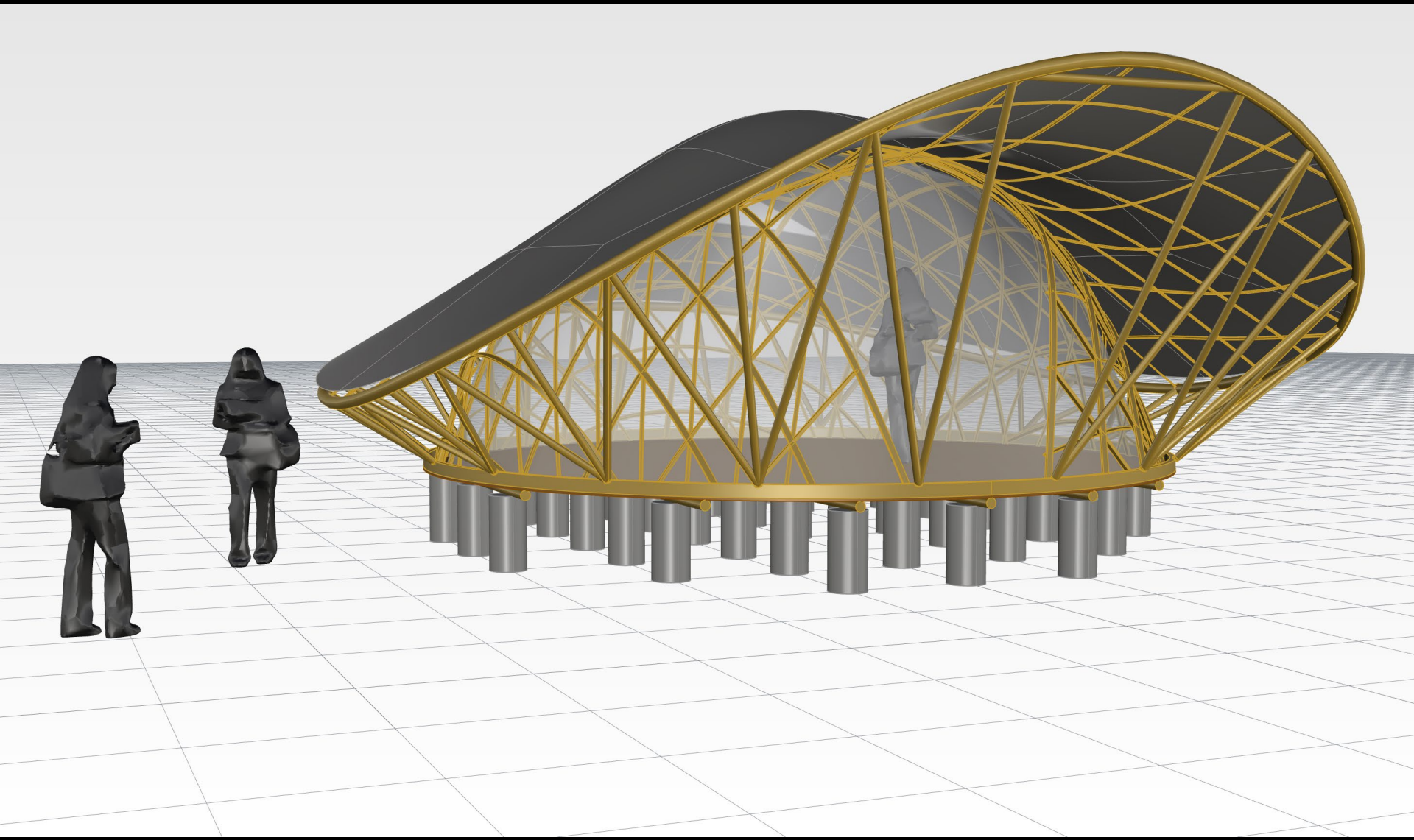
KEPITING BAMBU
Construction sequence

x2



KEPITING BAMBU
Construction sequence

x2



KEPITING BAMBU
Site condition

KEPITING BAMBU
Onsite client briefing

Elora Hardy (IBUKU)

Orin Hardy (Bamboo U)

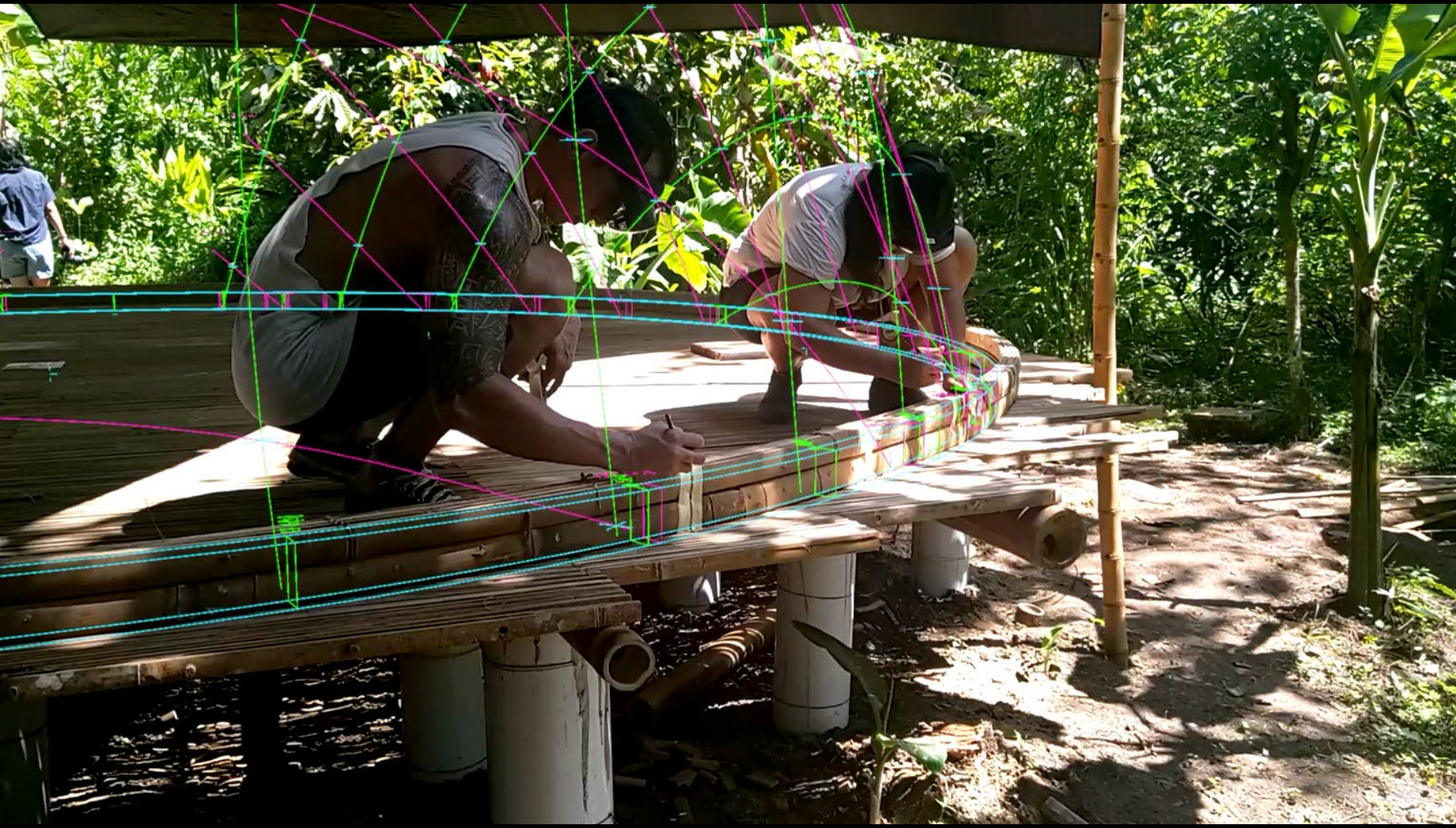

KEPITING BAMBU
Onsite client briefing

KEPITING BAMBU
Onsite position and orientation check

KEPITING BAMBU
Foundation set-out

KEPITING BAMBU
Foundation

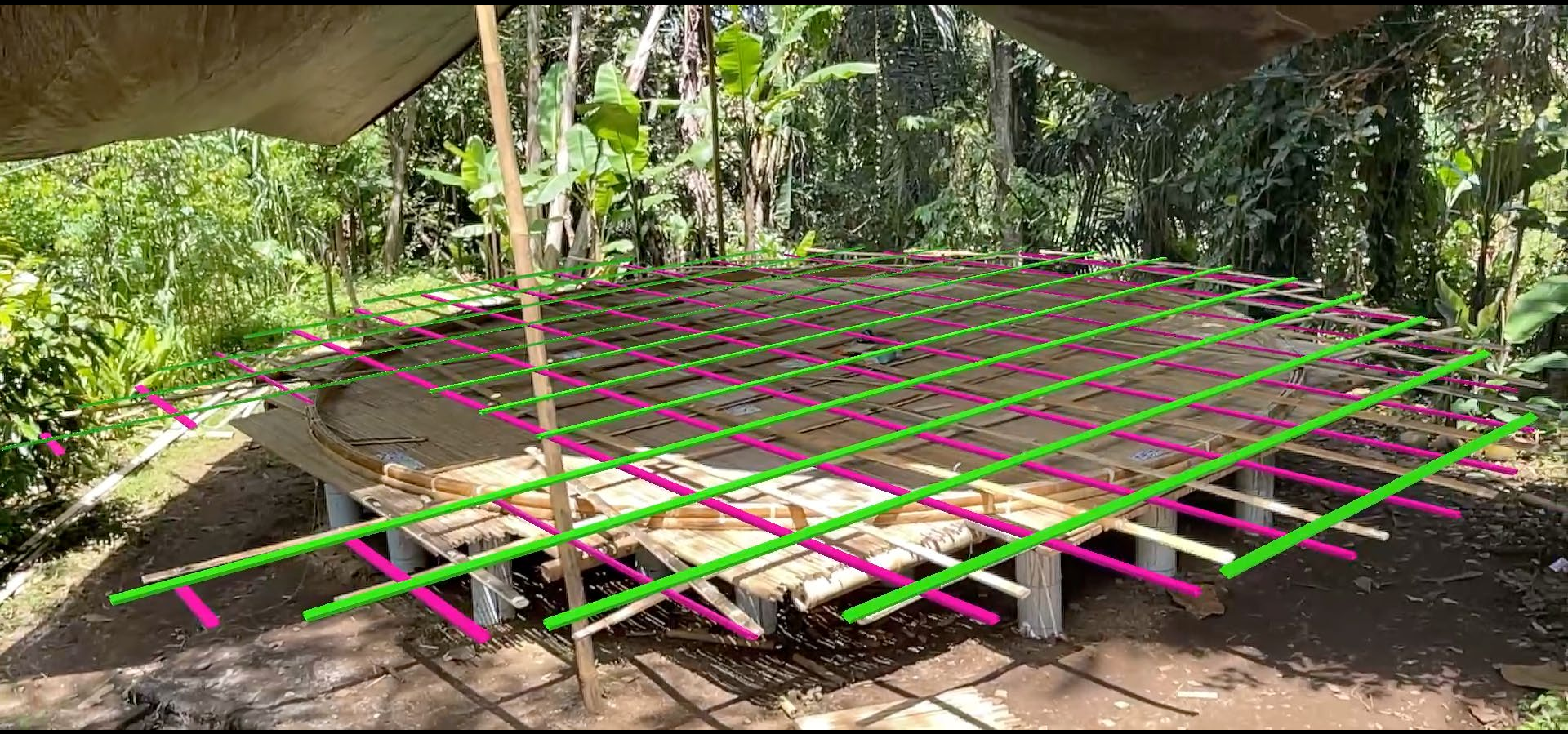
KEPITING BAMBU
Bottom ring beam



KEPITING BAMBU
Participant's using

KEPITING BAMBU
Main grid fabrication

KEPITING BAMBU
Main grid popping-up (simulation)



KEPITING BAMBU
Main grid popping-up

KEPITING BAMBU
Main grid popping-up

KEPITING BAMBU
Main grid fixing

KEPITING BAMBU
Top grid installation

KEPITING BAMBU
Lidi bundle installation

KEPITING BAMBU
Lidi bundle installation

KEPITING BAMBU
Lidi bundle support marking

KEPITING BAMBU
Lidi bundle support marking

KEPITING BAMBU
Workshop end

KEPITING BAMBU
Workshop end

TO BE CONTINUED…

BAMBOO U AUGUST 2023

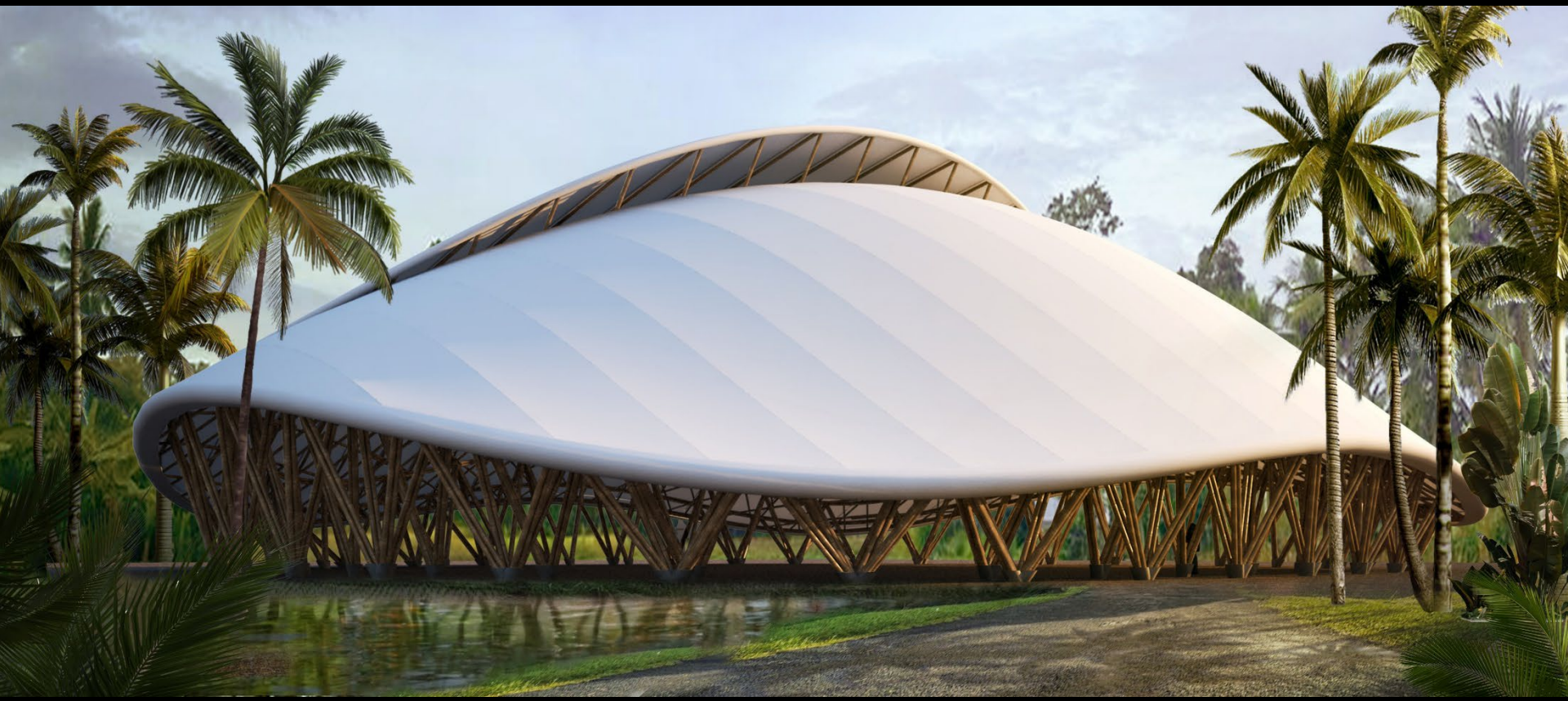
BAMBOO U HALL

4 March 2024

BALI BAMBOO HALL

Indonesia, 2024 (tbd.)

LEAD LABORATORY FOR EXPLORATIVE ARCHITECTURE & DESIGN



BALI BAMBOO HALL
Indonesia, 2024 (tbd.)

LEAD LABORATORY FOR EXPLORATIVE ARCHITECTURE & DESIGN

BALI BAMBOO HALL

Indonesia, 2024 (tbd.)

LEAD LABORATORY FOR EXPLORATIVE ARCHITECTURE & DESIGN

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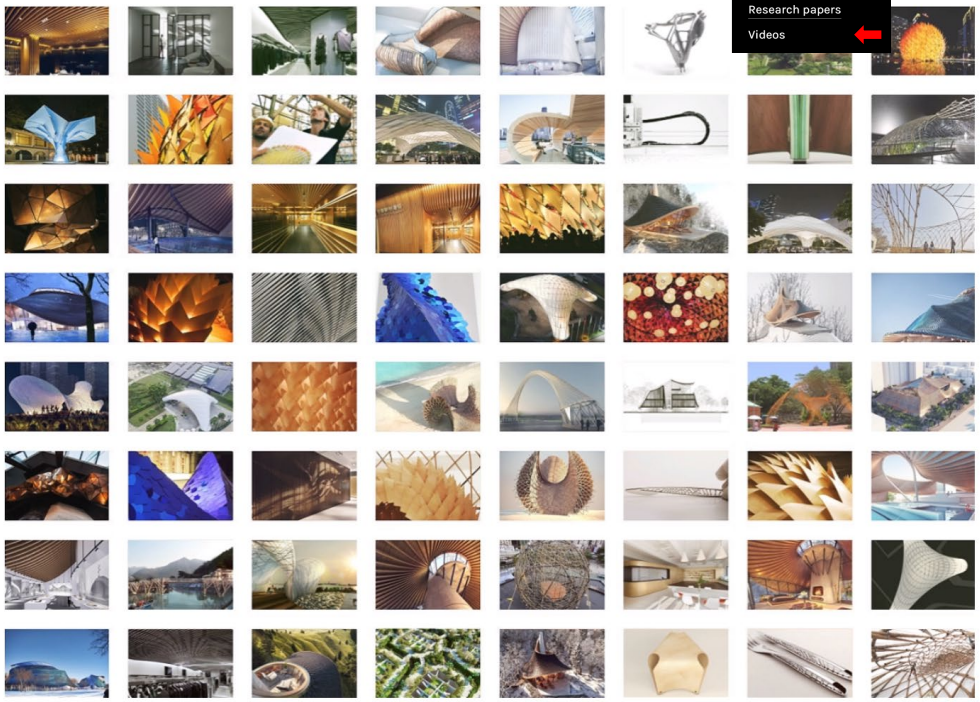
LEAD LABORATORY FOR EXPLORATIVE ARCHITECTURE & DESIGN



Highlights

Building Simplexity Laboratory

bsl.hku.hk/publications

BSL

Publications – Building Simplexity

bsl.hku.hk/publications/

BSL

ABOUT PROJECTS PUBLICATIONS TUTORIALS CONTACT

PUBLICATIONS

2023

- Architectural Education With Virtual Reality...
- Catenary Wooden Roof Structures...
- Resonance-In-Sight: Fabrication Of ...

2022

- Entering Hyper-Reality: "Resonance-In...

2021

- Creating Parametric Design...
- Expanding Bending-Active Bamboo...
- Secret Whispers & Transmogrifications...

2020

- AR-Based Collaboration...
- Augmenting Craft With Mixed Reality...
- Designing With Uncertainty...

2019

- 'Peer Critique' In Debate: A Pedagogical...
- Automation Complexity – Brick By...
- Design Practice Complexity In The...
- Simplifying Catenary Wood Structures
- Simplifying Doubly Curved Concrete...

2018

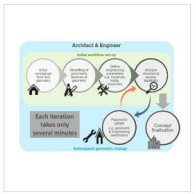
- Architect's Feasible Design Solution...
- Bending Bamboo Rules: Beyond Century...
- Beyond Architecture: How Computation ...
- Building Collaborative Creativity...
- Building Simplexity: The 'More Or Less'...
- Choreographed Architecture – Body...
- CU-Brick Cable-Driven Robot For...
- Inflatable Architecture Production With...
- Interaction Between Parametric...

2017



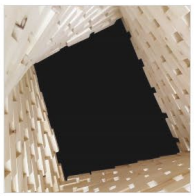


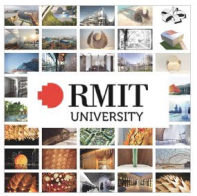


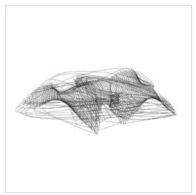


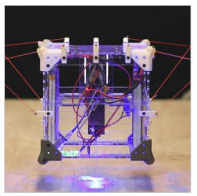
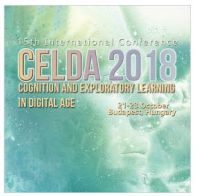


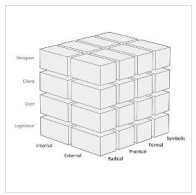












1. INTRODUCTION
2. MAIN DESIGN TOOLS
2.1. BENDING CURVES
01. Single Curve
02. Curve Network
03. Surface Curve Network
2.2. POP-UP GRIDSHELLS
01. Pop-Up Grid
02. Pop Up Grid: Diagonals
03. Pop Up Grid: Diagonals + Ties
2.3. SINGULARITIES
01. Singularities
02. Singularities: Joining Curves
03. Singularities: Kangaroo 2
04. Singularities + Mesh
05. Singularities: Distort
3. ANALYSIS TOOLS
3.1. CURVATURE
01. Curvature Analysis
02. Fingerprint Tool
3.2. STRUCTURAL PERFORMANCE
01. Structural Evaluation: Karamba3D
02. Pop-Up Grid: Struct. Eval. (Prep)
03. Singularities: Struct. Eval. (Prep) (1)
04. Singularities: Struct. Eval. (Prep) (2)
4. VISUALISATION TOOLS
5. FABRICATION TOOLS
6. TAXONOMY
7. EXAMPLES
7.1 BUILT PROTOTYPES
01. ZCB Bamboo Pavilion
02. TOROO
03. Belas Bambu
7.2 CONCEPT DESIGNS
01. Rural Construction Studio

BENDING-ACTIVE BAMBOO SHELL STRUCTURES:

Methods And Guidelines For Best Architectural Design Practice

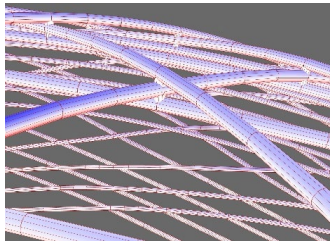
This research was supported by a grant from the Research Grants Council of the Hong Kong Special Administrative Region China: Project No. 14604618. Principal Investigator: Dr Kristof Crolla; Research Assistants: Garvin Goepel, Julien Klisz.

1. Background

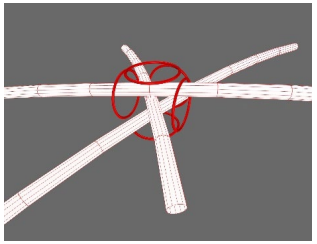
A combination of vernacular bamboo craftsmanship and digital design technology enables radically unique and spatially versatile architectural solutions rooted in local culture and sustainable building practices. This research project builds on

DOME Model Geometry Setup

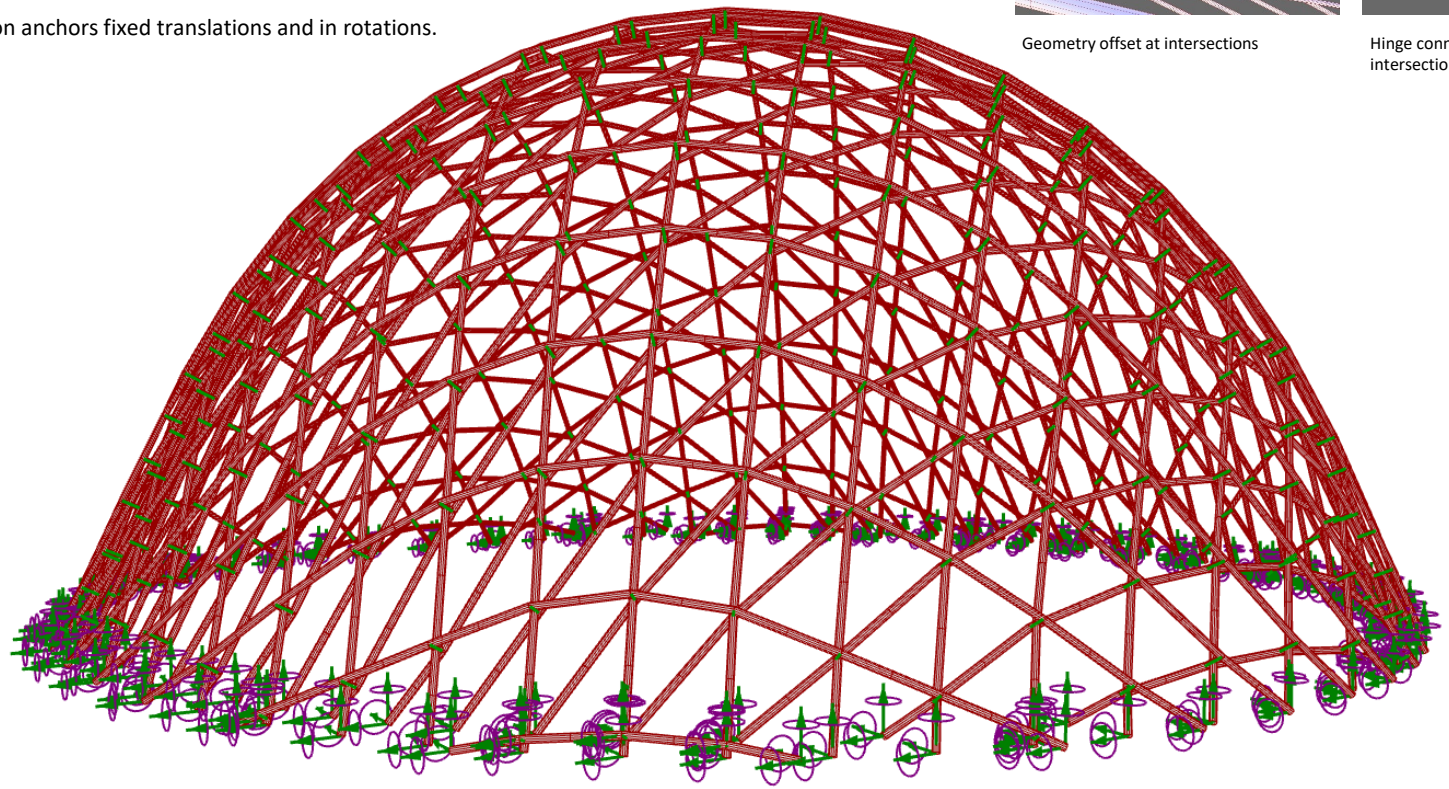
- Interconnected bamboo culms were abstracted to a total of 69 continuous curves, split into 988 lines
- At crossings, intersecting lines were offset and given a freely-rotating hinged connection.
- Foundation anchors fixed translations and in rotations.



Geometry offset at intersections

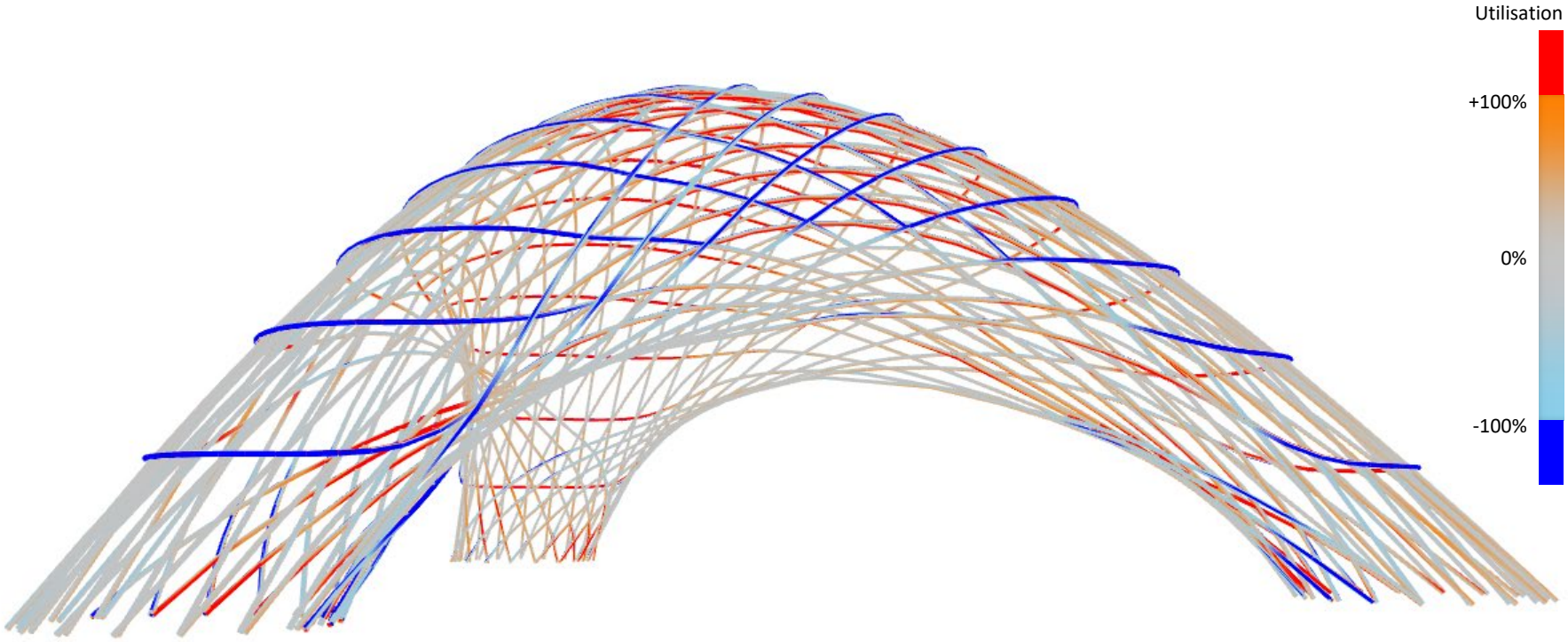


Hinge connections at intersections

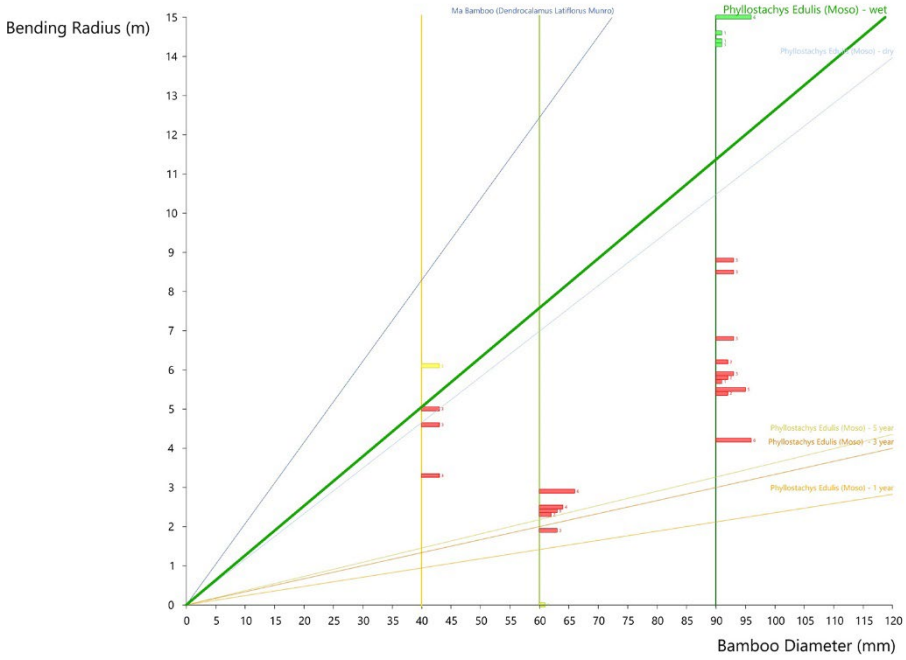


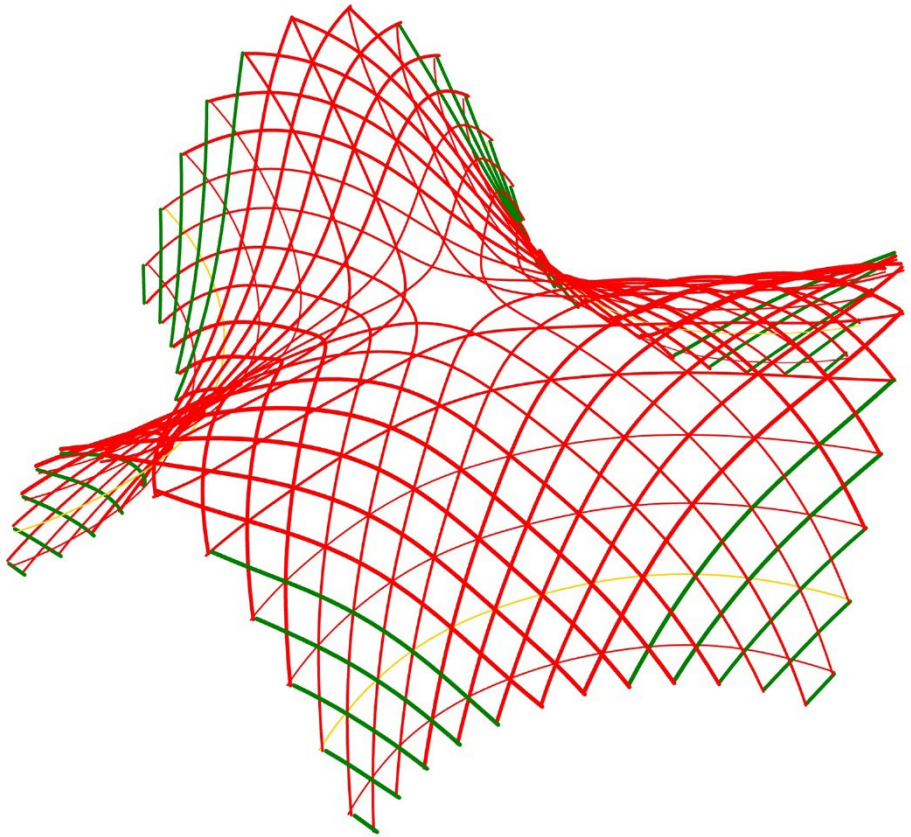
Karamba Evaluation

E.g. Material stress in load case 3 (SW+ Western wind + Initial Strain)



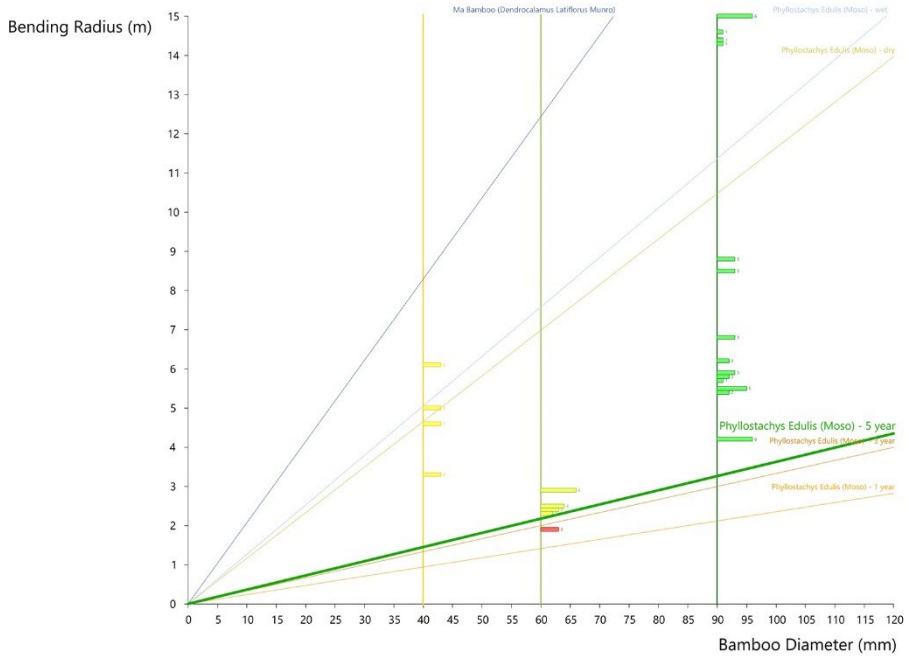
[-462.7% - 454.7%]

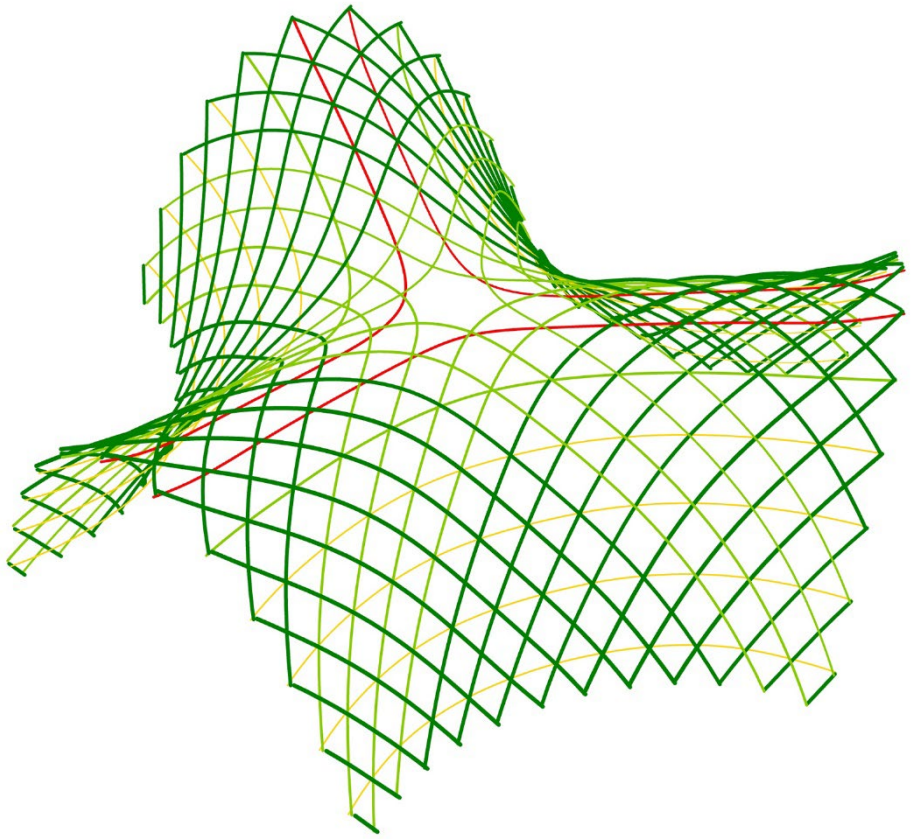

Bending Radius (m)
Ma Bamboo (Dendrocalamus Latiflorus Munro)
Phyllostachys Edulis (Moso) - wet
Phyllostachys Edulis (Moso) - dry
Phyllostachys Edulis (Moso) - 5 year
Phyllostachys Edulis (Moso) - 3 year
Phyllostachys Edulis (Moso) - 1 year
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100 105 110 115 120
Bamboo Diameter (mm)



bsl.hku.hk/babss

Species Selection Optimisation





bsl.hku.hk/tutorials

HKU EXCELLENCE AWARDS

>120,000 visits from >7,500 unique users from 129 different countries

>115,000 exercise file downloads

BSL

ONLINE E-LEARNING DATABASE FOR FLIPPED-CLASSROOM TUTORIALS ON DIGITAL DESIGN TOOLS & TECHNIQUES IN ARCHITECTURE

HKU

As recent technological evolutions are radically reshaping all aspects of architectural design, it is essential for future generations to gain a critical understanding of latest new modes of operation.

This online learning platform, developed by the Building Simplexity Lab (BSL) and colleagues from Department of Architecture, coherently centralises and coordinates relevant tutorials on digital design tools & techniques for architecture and the built environment. Lessons can be easily searched and queried by students and incorporated into flipped-classroom teaching by instructors across and beyond our faculty.

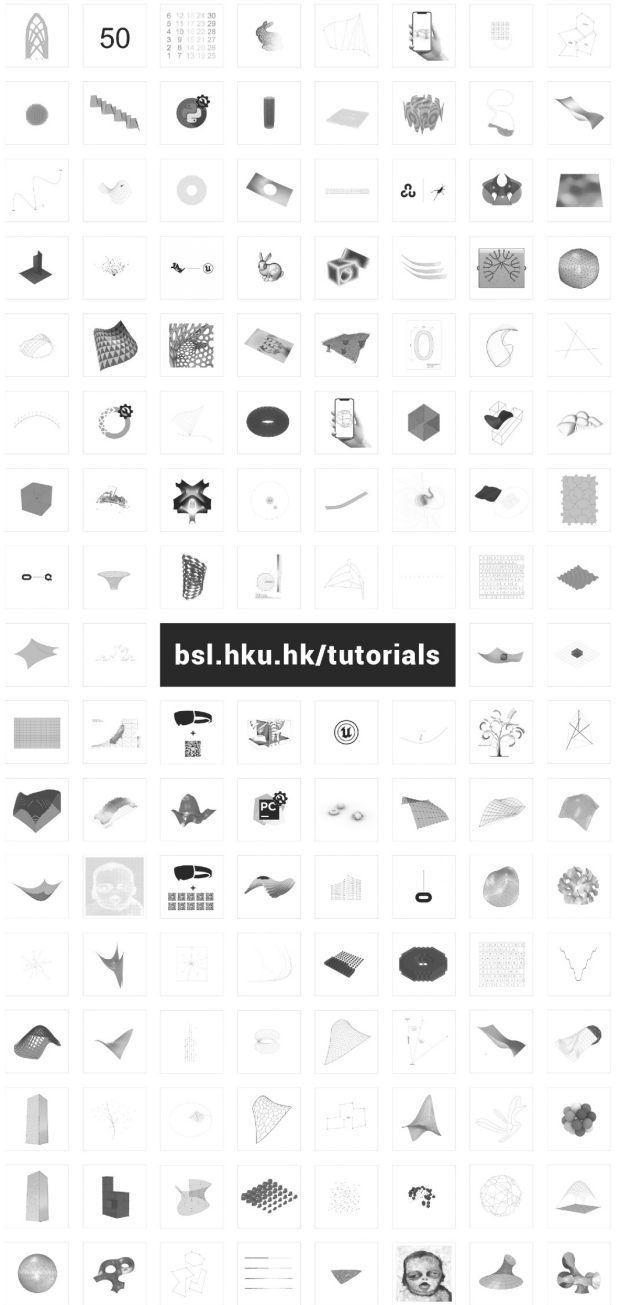
As our 'digital design toolbox' expands, knowledge retention throughout generations of students becomes challenging. Available time to focus on specialised or advanced applications is limited. This database aims to become an essential online learning platform to allow students to navigate and meaningfully engage with the rapidly increasing volume and diversity of digital material and technology that they need in design, production, and management processes. This website strives to facilitate the integration of computation and digital learning across faculties and will become an invaluable long-term industry-focused resource both for students and graduates.

The index for now largely centres on the 3D NURBS modelling software platform Rhinoceros and its procedural modeller Grasshopper – a powerful procedural design tool that allows you to create through algorithmic design processes, that is widely used in the architecture and design fields, and that can greatly enhance digital literacy and design capabilities. The website contains over 130 exercises, many with pre-recorded video tutorials, with more to come in the near future, covering a range of topics from the basics of grasshopper to more advanced techniques and plugins. This growing list already includes topics like 1) Geometry, 2) Recursive scripting, 3) Particle systems & agent-based design, 4) Evolutionary solvers, 5) Workflow & fabrication, 6) Visualisation & rendering, 7) Physics simulation& structural analysis, 8) Energy & building simulation, 9) Extended reality, 10) Coding, Etc.

We encourage all students to take advantage of this resource and explore the many possibilities that grasshopper has to offer. It is our hope that this tutorial website will help increase agency in the design studio and give you the tools to create truly unique and innovative designs.

Enjoy!

March 2023



Principal Investigator:
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Co-Investigators:
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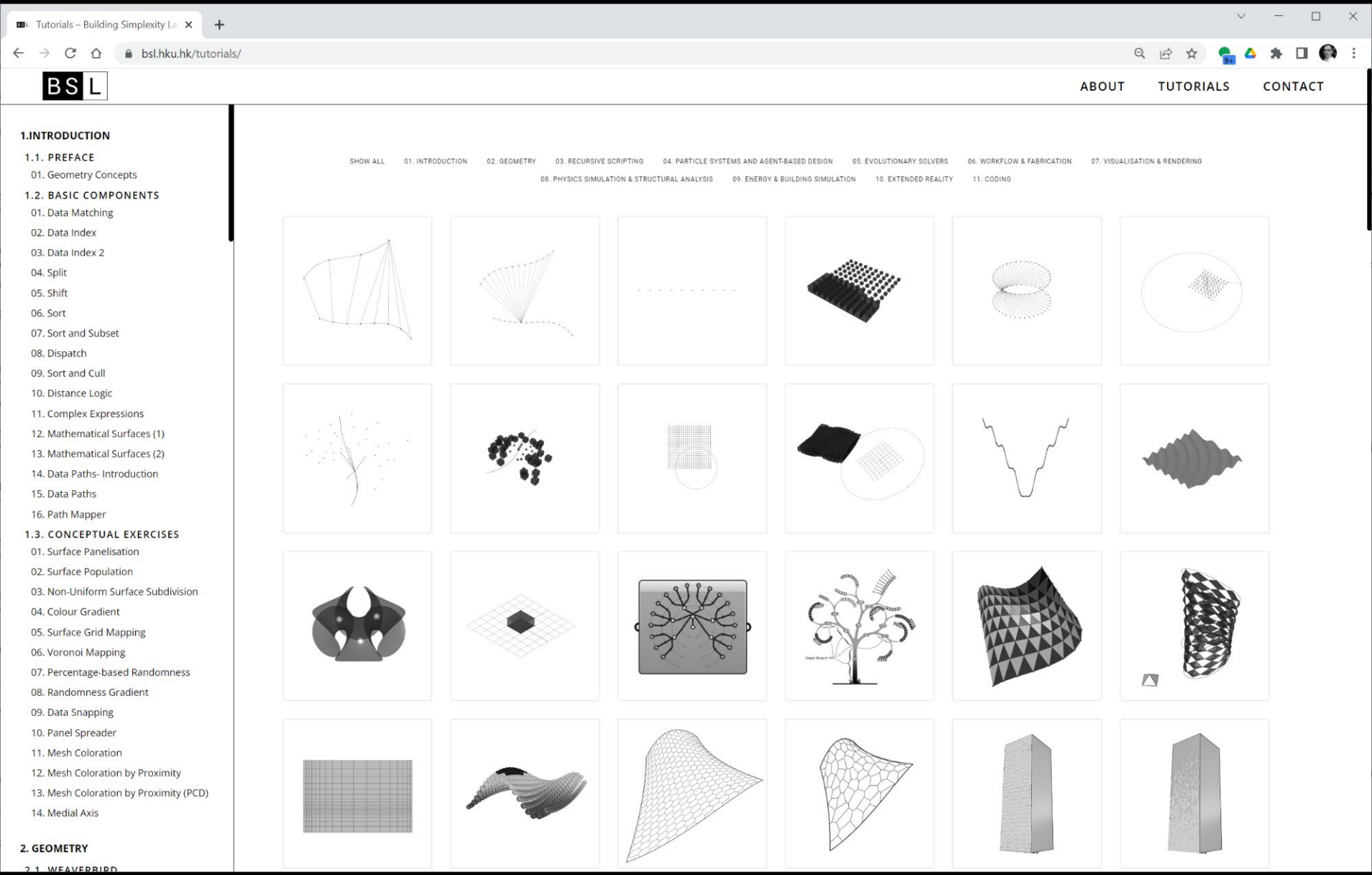


CONTENT:

- > 10 Main topics
- > 175 Exercises
- > 50 Video tutorials

Building Simplexity Laboratory

BSL

14. Data Paths- Introduction – Bu

bsl.hku.hk/data-paths-introduction/

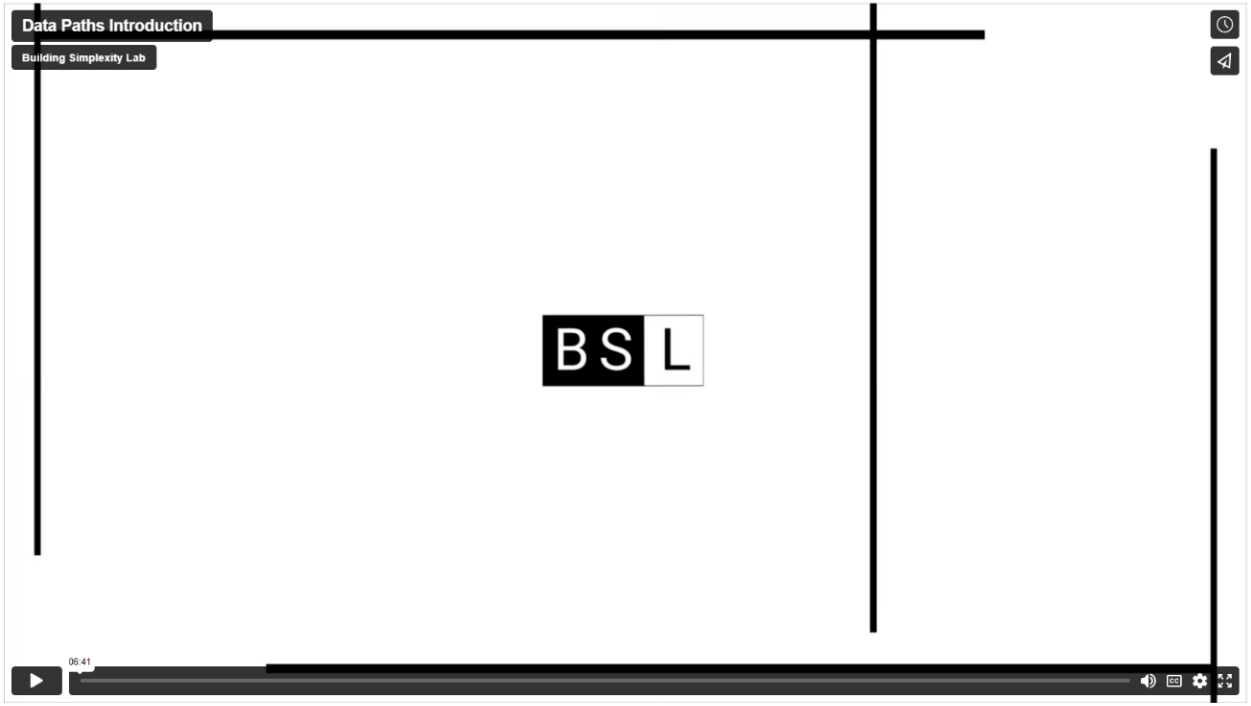
BSL

ABOUT TUTORIALS CONTACT

1.INTRODUCTION
1.1. PREFACE
01. Geometry Concepts
1.2. BASIC COMPONENTS
01. Data Matching
02. Data Index
03. Data Index 2
04. Split
05. Shift
06. Sort
07. Sort and Subset
08. Dispatch
09. Sort and Cull
10. Distance Logic
11. Complex Expressions
12. Mathematical Surfaces (1)
13. Mathematical Surfaces (2)
14. Data Paths- Introduction
15. Data Paths
16. Path Mapper
1.3. CONCEPTUAL EXERCISES
01. Surface Panelisation
02. Surface Population
03. Non-Uniform Surface Subdivision
04. Colour Gradient
05. Surface Grid Mapping
06. Voronoi Mapping
07. Percentage-based Randomness
08. Randomness Gradient
09. Data Snapping
10. Panel Spreader
11. Mesh Coloration
12. Mesh Coloration by Proximity
13. Mesh Coloration by Proximity (PCD)
14. Medial Axis

2. GEOMETRY
2.1. WEAVERBIRD

1.2.14. DATA PATHS INTRODUCTION



52 total views, 1 views today

Date published: August 9, 2022

DESCRIPTION

This exercise introduces the importance of data paths: the “addresses” or access paths where specific geometric data is stored and accessed from.

PROCEDURE

1.Create two surfaces and add them both into one button: a list shows two items in one branch address. 2.Explode all items from the list: a list connecting to the “edge” output shows two branches with 4 items, the four edges of the surfaces.
3.Flip matrix: by flipping the matrix instead of having 2 branches with 4 items, we create 4 branches with two items: the first two edges, the second two edges, the third two edges and the fourth two edges.
4.The loft command lofts all the edges within one branch of the data tree.

SOFTWARE
Rhino
Grasshopper

PLUGINS
–

COURSE FILES
Data_Paths_Introduction.zip
984.15 KB | 3 downloads

CONTENT:
- > 10 Main topics
- > 175 Exercises
- > 50 Video tutorials

Building Simplexity Laboratory

BSL

32. Planar Quads – Building Simp

bsl.hku.hk/planar-quads/

BSL

ABOUT TUTORIALS CONTACT

- 26. Tension Membrane from Developable S
- 27. Fixed Boundary Bending Structure
- 28. Inflatable with Tension Wire
- 29. Sphere Packing
- 30. Curly Kale
- 31. Growing Curve on Surface
- 32. Planar Quads

8.2. KIWI!3D
- 01. Linear Analysis
- 02. Non-Linear Analysis
- 03. Form Finding

8.4. AMEBA
- 01. 2D Topology Optimisation
- 02. 3D Topology Optimisation

9. ENERGY & BUILDING SIMULATION

9.1. LADYBUG
- 01. Sunpath and sunlight hour analysis
- 02. Wind rose
- 03. Psychometric Chart
- 04. Solar Temperature Adjustor
- 05. 3D Chart

9.2. GH WIND
- 01. Wind Flow Analysis

10. EXTENDED REALITY

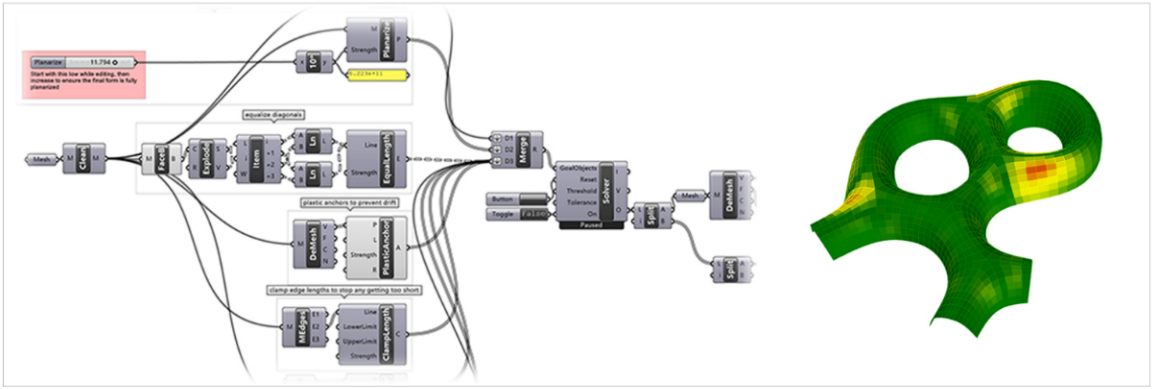
10.1. FOLOGRAM
- 01. Display Geometry
- 02. Fabricating in AR
- 03. HoloLens And Image Tracking
- 04. Accurate Positioning With Twinbuild

10.2. INTRODUCTION TO VR
- 01. Rhino to Unreal Bridge: Installation
- 02. Oculus app to Quixel
- 03. Introduction to Unreal basics
- 04. Enabling VR-PC link headset

11. CODING

11.2. CONFIGURATIONS

8.1.32. PLANAR QUADS



45 total views, 1 views today

Date published: August 27, 2022

DESCRIPTION

This powerful exercise allows you to plastically modify a given mesh, and then smoothen and convert it into a mesh made from fully planar quad.

PROCEDURE

1.Flattens each of the quads in a mesh.
2.Equalises the diagonal length of each of the quads.
3.Plastic anchor to prevent drift.
4.ClampLength keeps the distance between 2 points between given bounds but applies no force when the distance is within these limits.
5.Uniform Laplacian smoothing rounds any sharp features of a mesh.

This exercise is using Grasshopper version 1.0.0007
References: Daniel Piker, Kangaroo Physics (by Daniel Piker), https://www.food4rhino.com/app/kangaroo-physics, Accessed August 6, 2020

SOFTWARE
Rhino
Grasshopper

PLUGINS
Kangaroo 2

COURSE FILES
Planar_Quads.zip
464.55 KB | 25 downloads



CONTENT:
- > 10 Main topics
- > 175 Exercises
- > 50 Video tutorials

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Extended Reality

BSL

DATABASE OF E-LEARNING TUTORIALS FOR FLIPPED-CLASSROOM TEACHING OF AUGMENTED/VIRTUAL REALITY TOOLS AND TECHNIQUES FOR ARCHITECTURE

HKU

Augmented Reality (AR) and Virtual Reality (VR) have emerged as pivotal tools, fundamentally altering the way architects conceptualise, visualise, and bring designs to life. Extended Reality (XR) technology both complements and revolutionises our toolbox, marking a significant paradigm shift and redefining the boundaries of architecture design conception and implementation.

This fall, the Building Simplexity Lab (BSL) launches a series of online XR-specific tutorials on the BSL tutorial website. Their instructional framework is tailor-made for architectural design with a specific focus on customising AR/VR capabilities. Along with the existing available database of Grasshopper tutorials, this integration of XR tutorials forms a vital online learning platform that seamlessly covers architectural design processes, from conception to visualisation and construction. Students can search, access, and engage with the exercises, which can easily be integrated into a flipped classroom teaching courses by colleagues both within and outside the faculty and university.

The tutorials comprehensively cover a range of specific and practical XR tools and techniques, ensuring participants gain a holistic understanding of this dynamic field. The content is divided into both an Augmented Reality and a Virtual Reality section. Tutorials commence with the technical tools used to create AR and VR content, leading users through a meticulous step-by-step workflow to craft immersive AR and VR environments. The scope of the AR and VR sections extends beyond mere software and device explanations, encompassing various applications from architectural design to construction. The design and sequence of the entire tutorial offer considerable flexibility: users can selectively explore specific chapters based on their content preferences. Tutorials can be used like a reference book, accessible either comprehensively or via segmented choices. The index focusses on hardware that is available in the Lab for general use, such as the Microsoft Hololens 2 and Meta's Oculus Quest 2, and on the most powerful common XR software platforms, including Unity, Unreal Engine, Fologram, Twinbuild, Twinmotion, Blender and Gravity Sketch.

We encourage all students to leverage this resource and delve into the multitude of possibilities that Extended Reality offers.

Enjoy!

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