Digital Fabrication

DM II Week 6

DES 212| Winter Term 2 | 2026 | 3 Credits

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GTAs: Lea Papillon, Wylie Moorman

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2. Model Scale: Fabricating Architectural Models
   Laser cutting • CNC milling • 3D printing • Kerfing & vacuum forming • Casting • Hybrid
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5. Building Scale: Formative

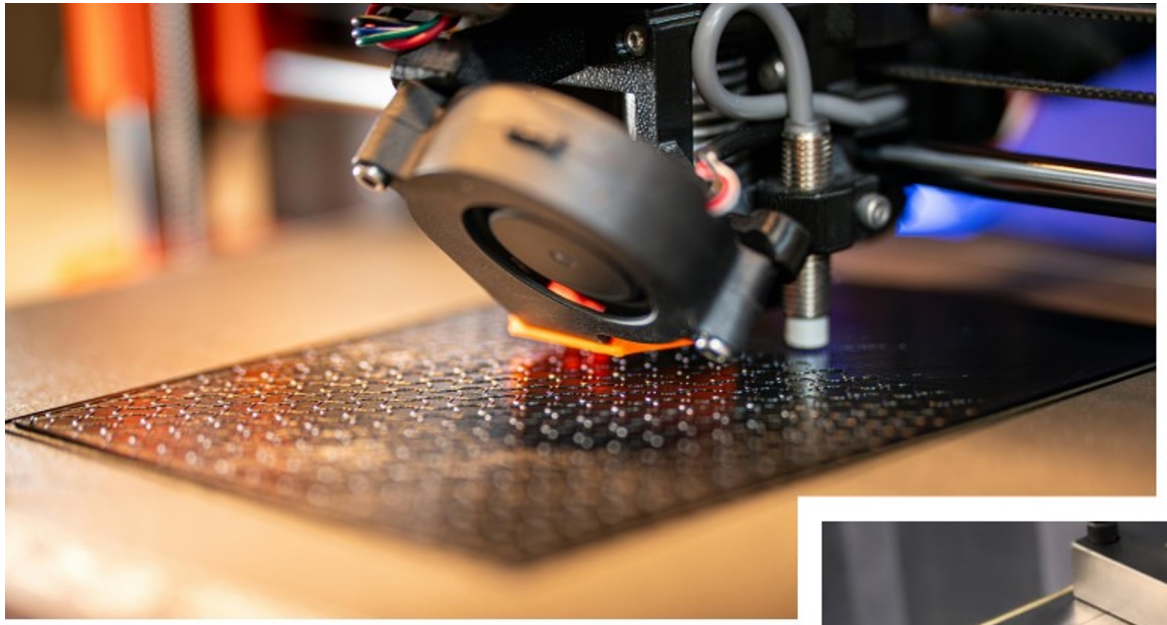
Part 1. Three Fabrication Logics

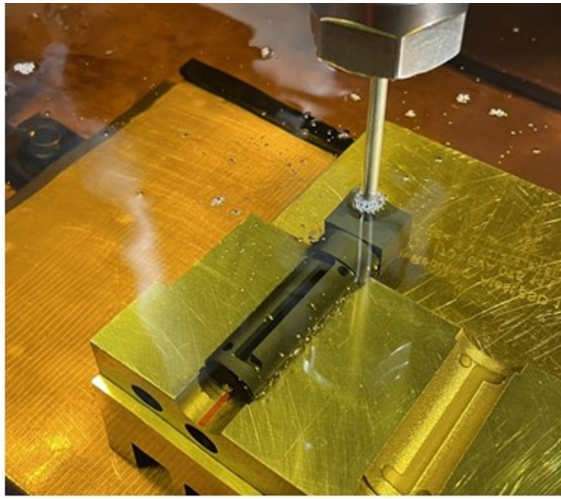
Part 1 — Three Fabrication Logics

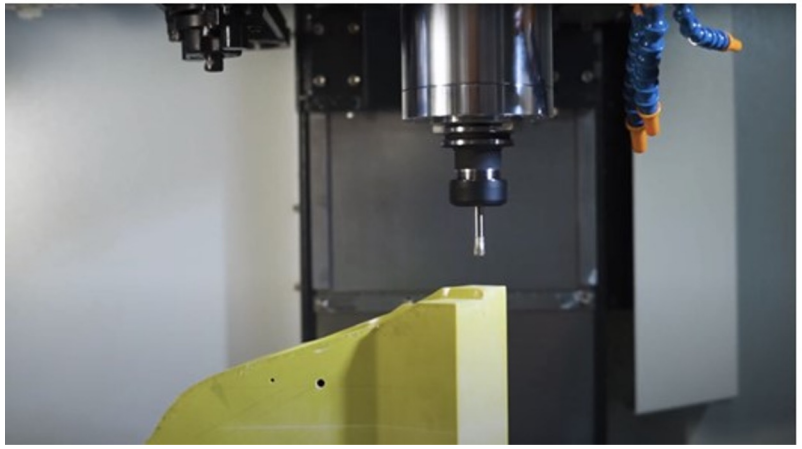
The Paradigm Shift

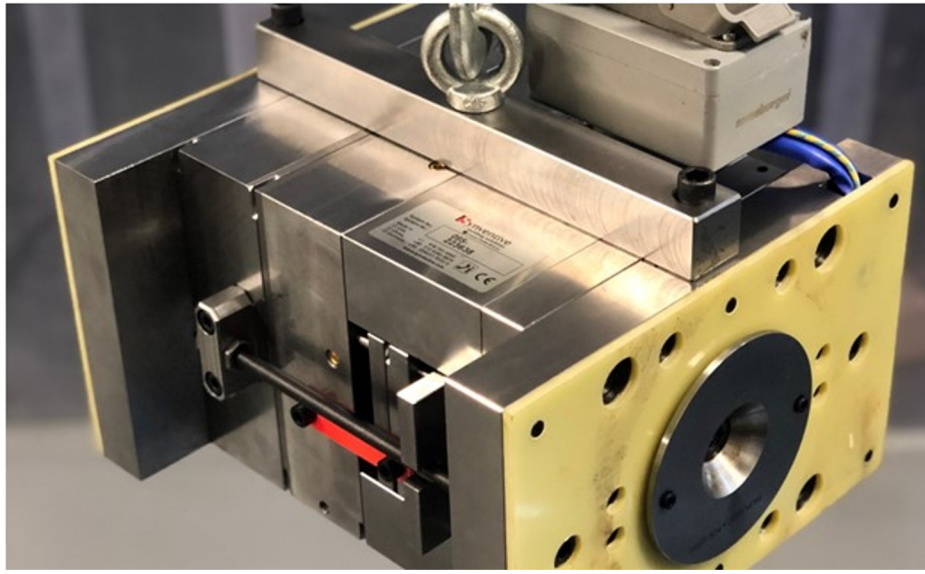
CAD to CAM: from drawing about a thing to encoding instructions to make a thing.

Digital fabrication bridges the gap between design software and physical output. The file-to-factory workflow transforms a digital model into toolpaths that drive machines to produce material results.







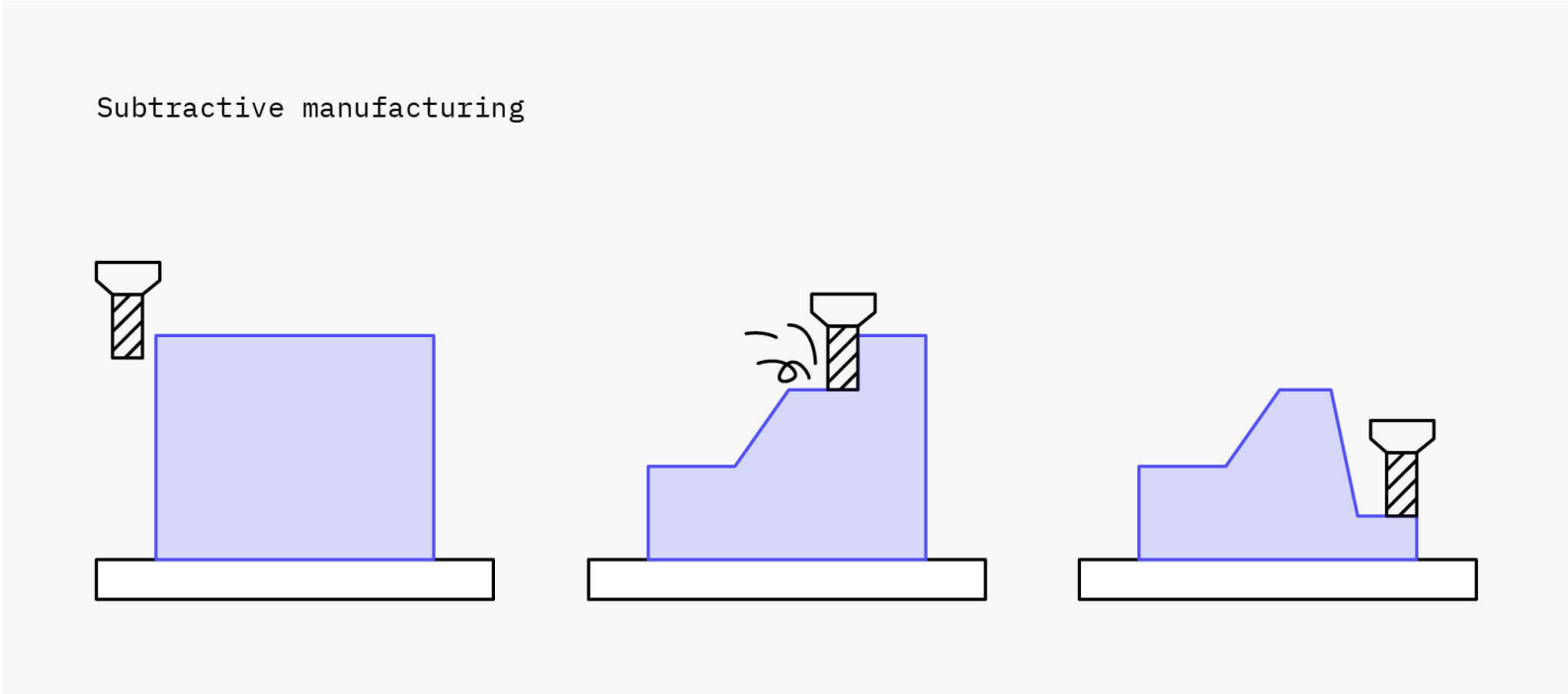


File-to-Factory Workflow
Digital model → Toolpath → Physical output

Subtractive — Material Removal

Start with a block or sheet, remove what you don’t need.

CNC milling, laser cutting, waterjet cutting. Constraints: tool access, undercutting, sheet size, material grain. The starting material defines what is possible.

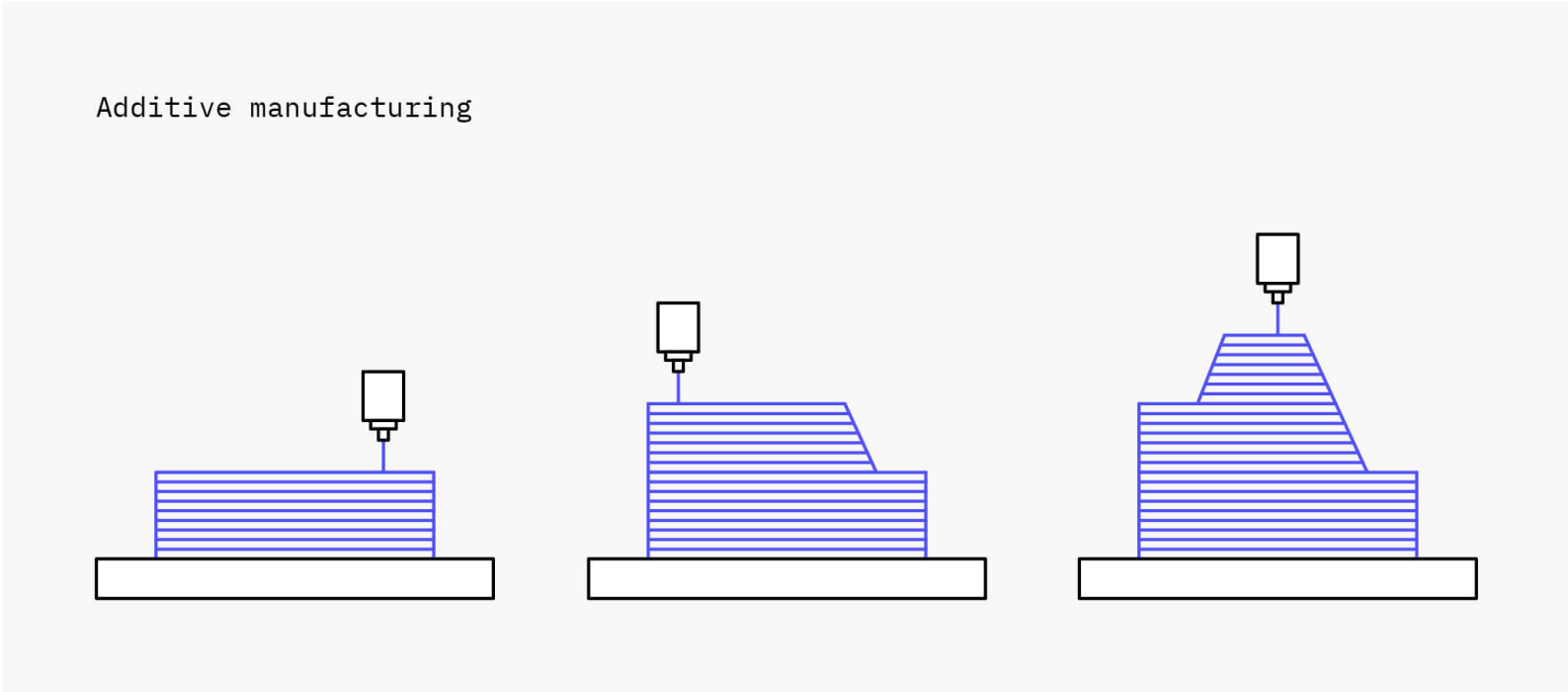


CNC Milling / Laser Cutting / Waterjet
2-axis to 7-axis machining

Additive — Material Deposition

Build layer by layer from nothing.

FDM, SLA, SLS, concrete extrusion, WAAM. Constraints: overhangs, supports, layer direction, build volume. Freedom of geometry but bound by gravity and material behavior.

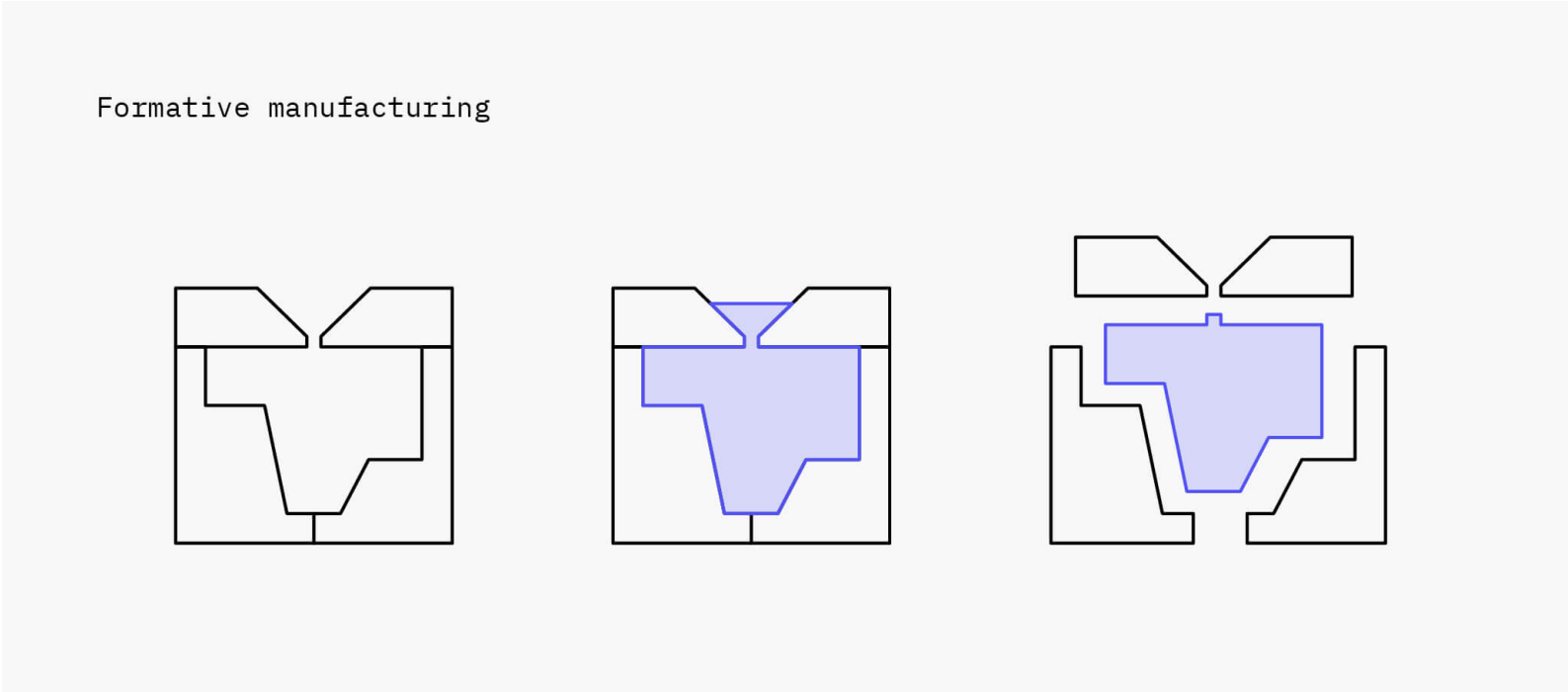


3D Printing / Material Extrusion
Layer-by-layer deposition

Formative — Material Deformation

Shape material without adding or removing mass.

Vacuum forming, kerf bending, steam bending, casting. Constraints: draft angles, material elasticity, mold complexity. The material is coerced into a new shape through force or heat.



Casting/Vacuum Forming / Kerf Bending / Deformation, bending & molding

File-to-Factory Pipeline

Design → Model → Toolpath → Machine → Object

Just as digital drawing gave control over line quality, digital fabrication gives control over material output. The design intelligence lives in the digital model and its parametric logic.

The Digital Fabrication Pipeline
Rhino/GH → CAM → G-code → CNC/3DP

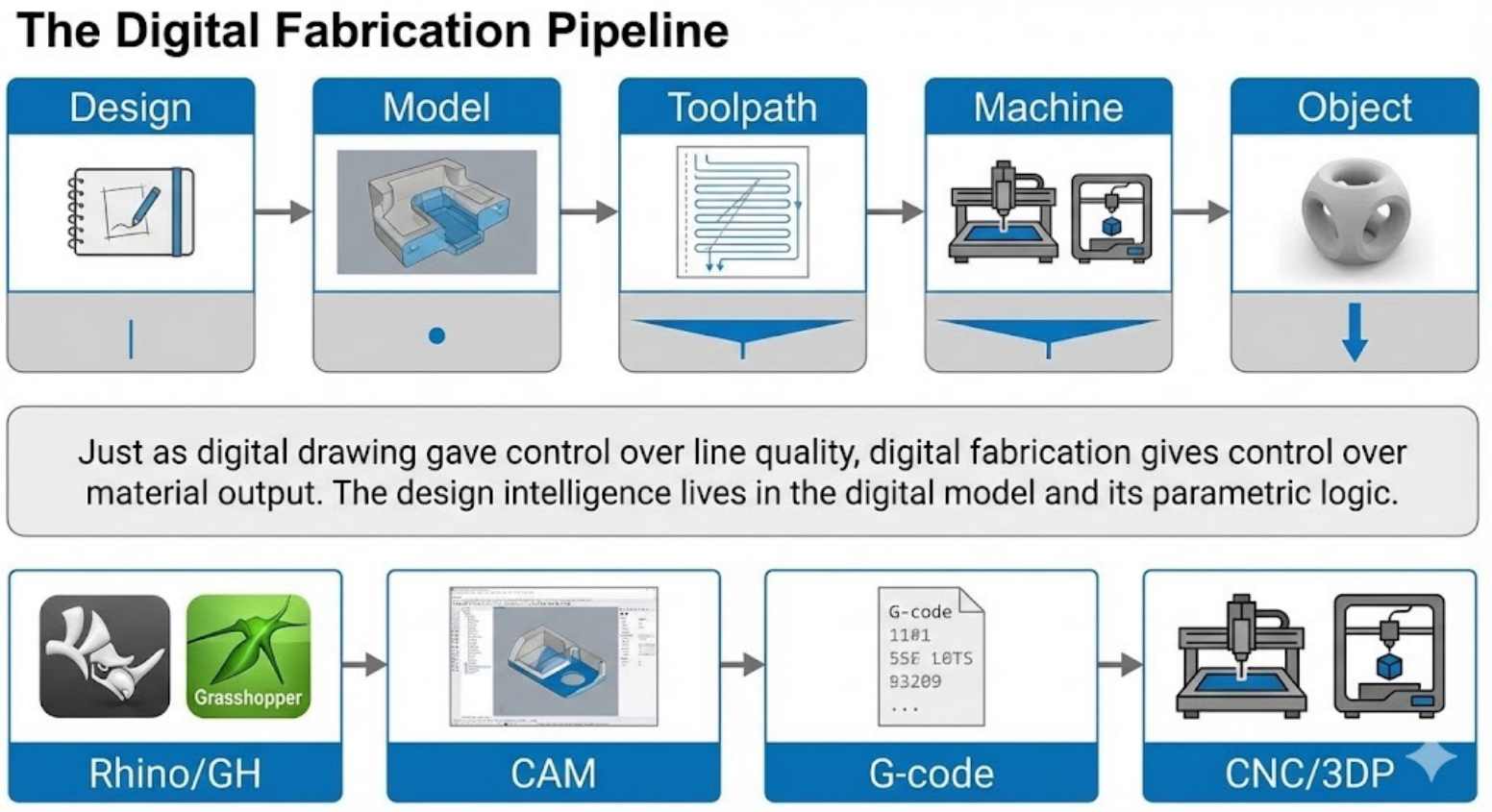


Diagram created by Gemini

Why Digital Fabrication?

1. Precision

Laser cuts to 0.1mm
Perfect curves every time

2. Complexity

Make impossible shapes
Twisted surfaces, intricate patterns

3. Speed

Print overnight → critique tomorrow
Renzo Piano: "Models change daily"

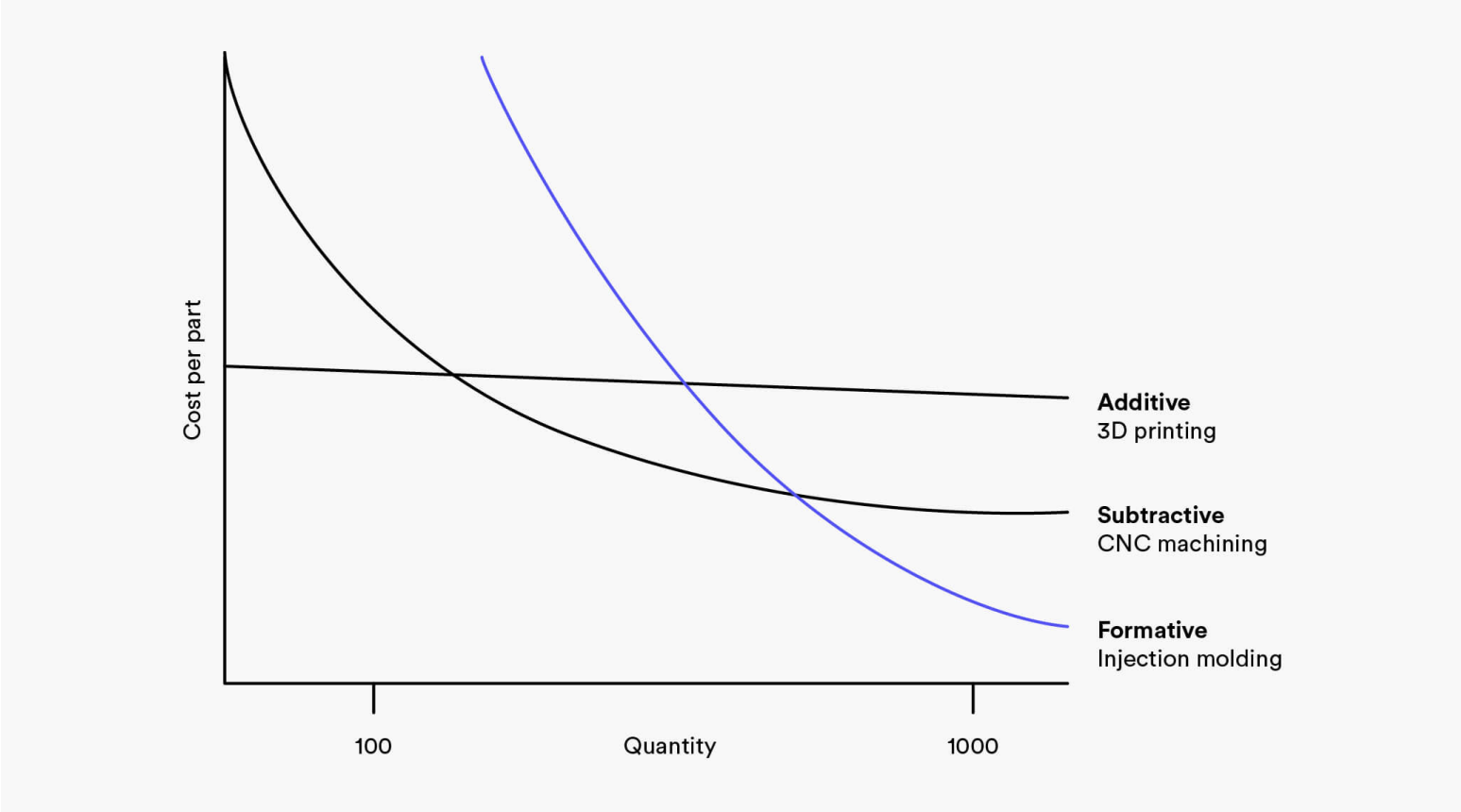
4. Communication

Show sections, sequences, context

Mass Customization

Each fabrication logic implies a different design vocabulary.

Subtractive = precision from stock.
Additive = complexity for free.
Formative = efficiency at scale.
Machine constraints become design opportunities. Most real projects combine two or more.



Subtractive • Additive • Formative
Constraints as design drivers

Mass Customization



Mass Customization

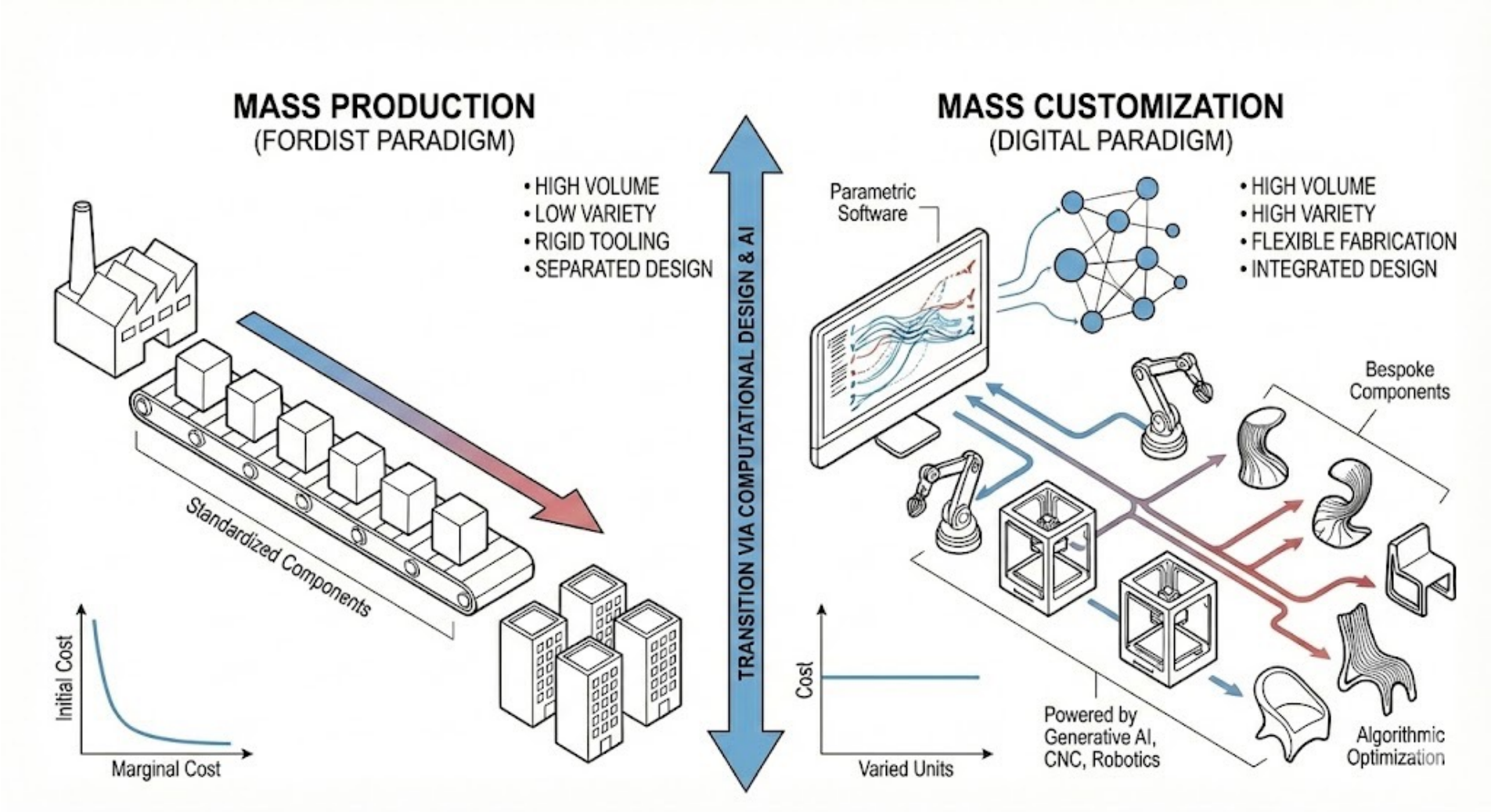


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Part 2. Model Scale: Fabricating Architectural Models

Part 2. Model Scale

Laser Cutting

The Basics:

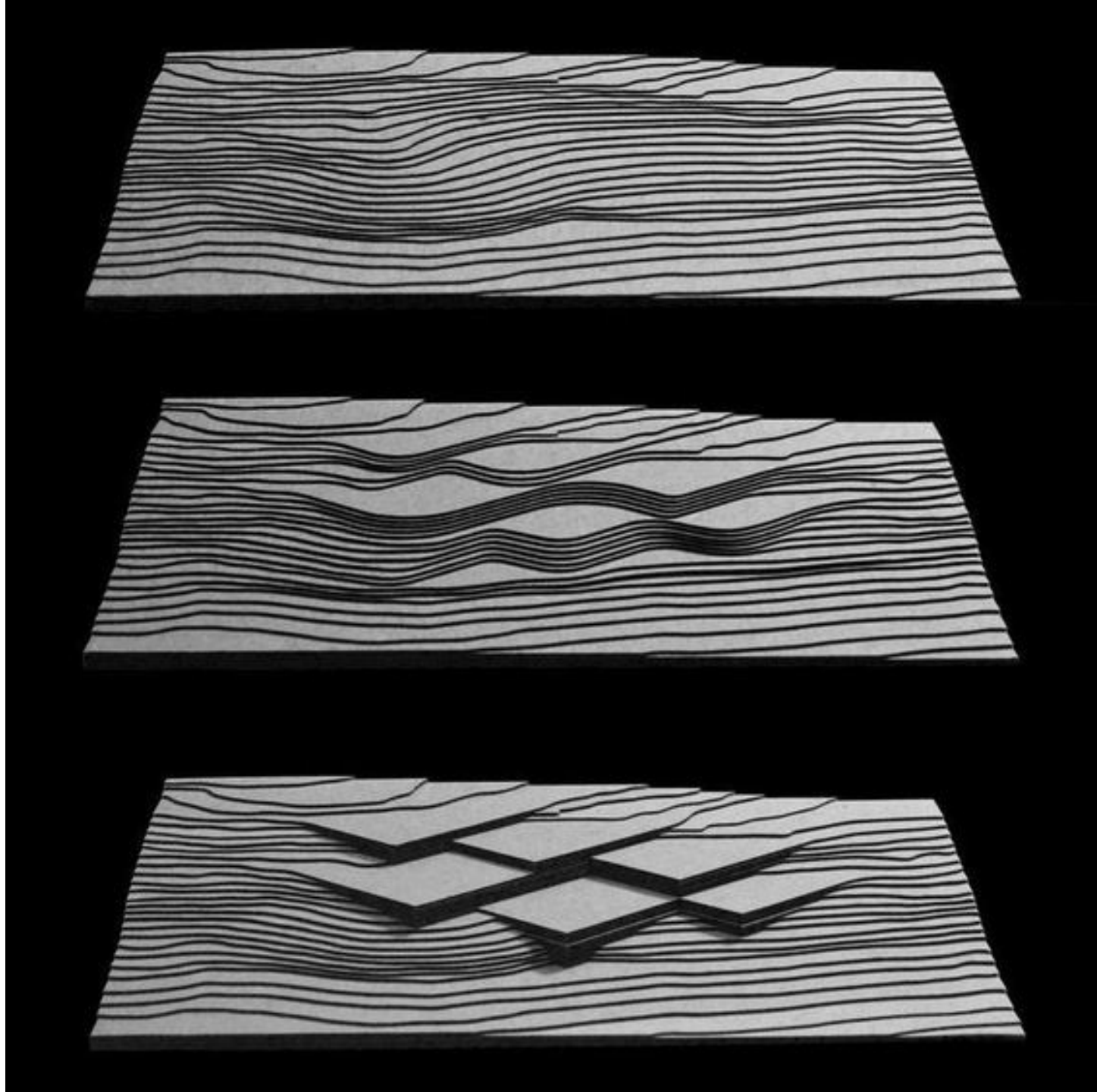
cut through VS surface
engrave

Materials:

Cardboard, wood, acrylic, MDF

Perfect for:

- Walls with openings
- Stacked topography
- Tab-and-slot assembly



CNC Milling

Computer Numerical Control

What is it?

Robot router carves foam or wood

Best for:

Site models with smooth hills
and valleys

You bring:

Digital terrain file (Google Earth or survey data)

Machine makes:

Smooth continuous landscape



CNC Milling

Computer Numerical Control

Foam
- Lightest weight
- Cuts fast
- Needs sanding

MDF
- Easy to paint
- Medium weight

Wood (mahogany)
- Most beautiful finish
- Expensive
- Takes 6+ hours





Part 2. Model Scale

3D Printing

FDM (plastic filament)

- Visible layer lines
- Fast & cheap
- Use for: quick studies

SLA (liquid resin)

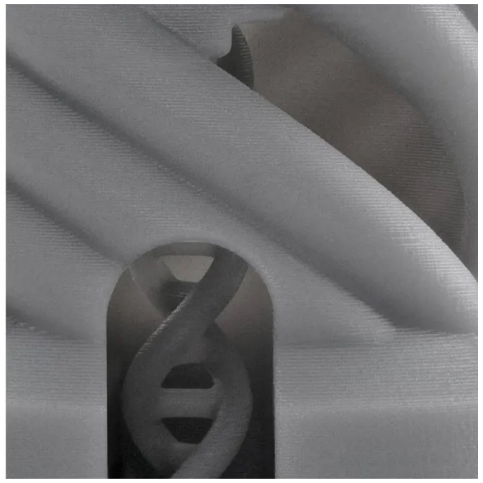
- Smooth surface
- Slower & pricier
- Use for: final presentations

SLS (powder)

- Good quality
- No supports needed
- Use for: complex lattice









Part 2. Model Scale

3D Printing

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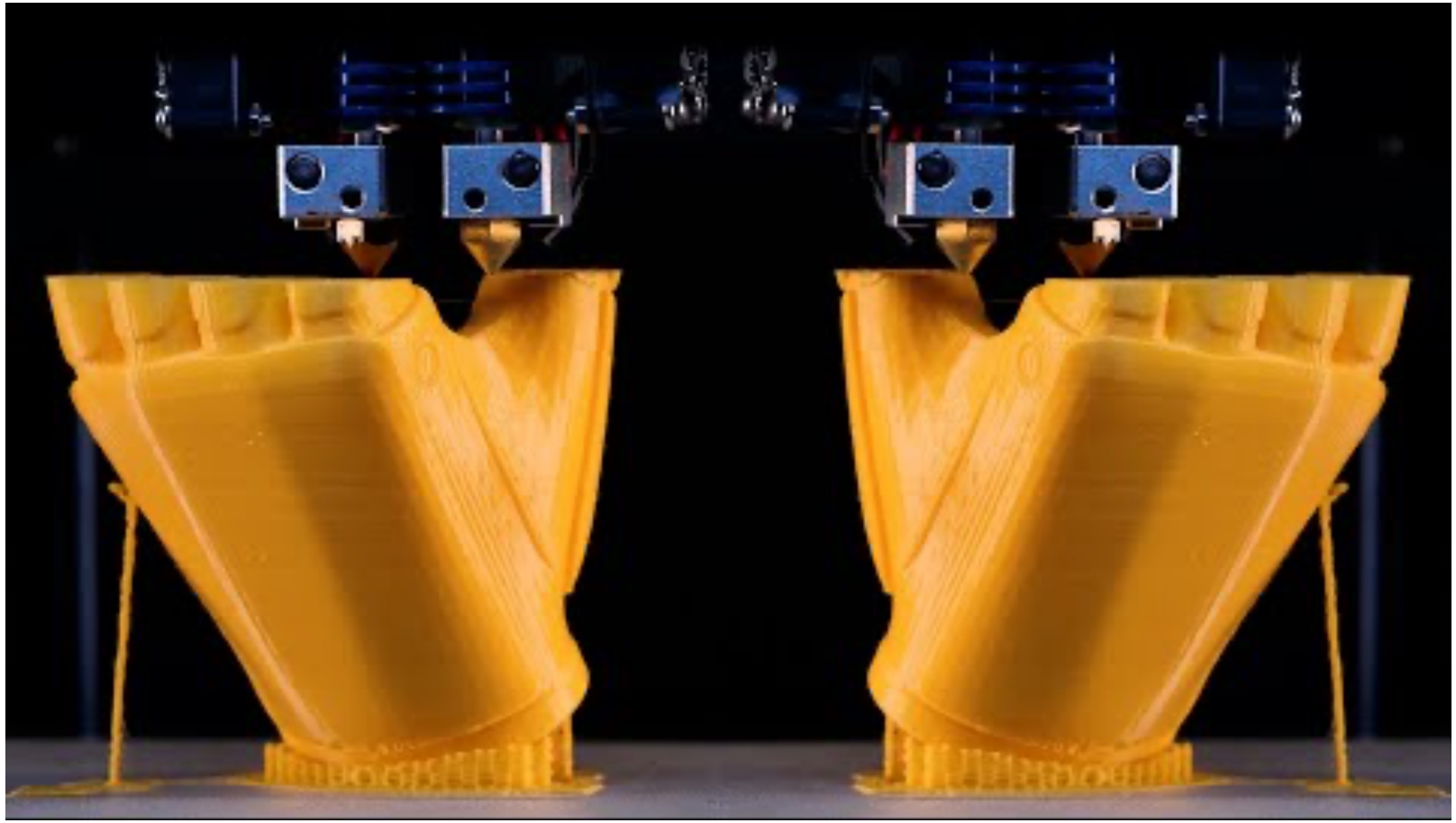
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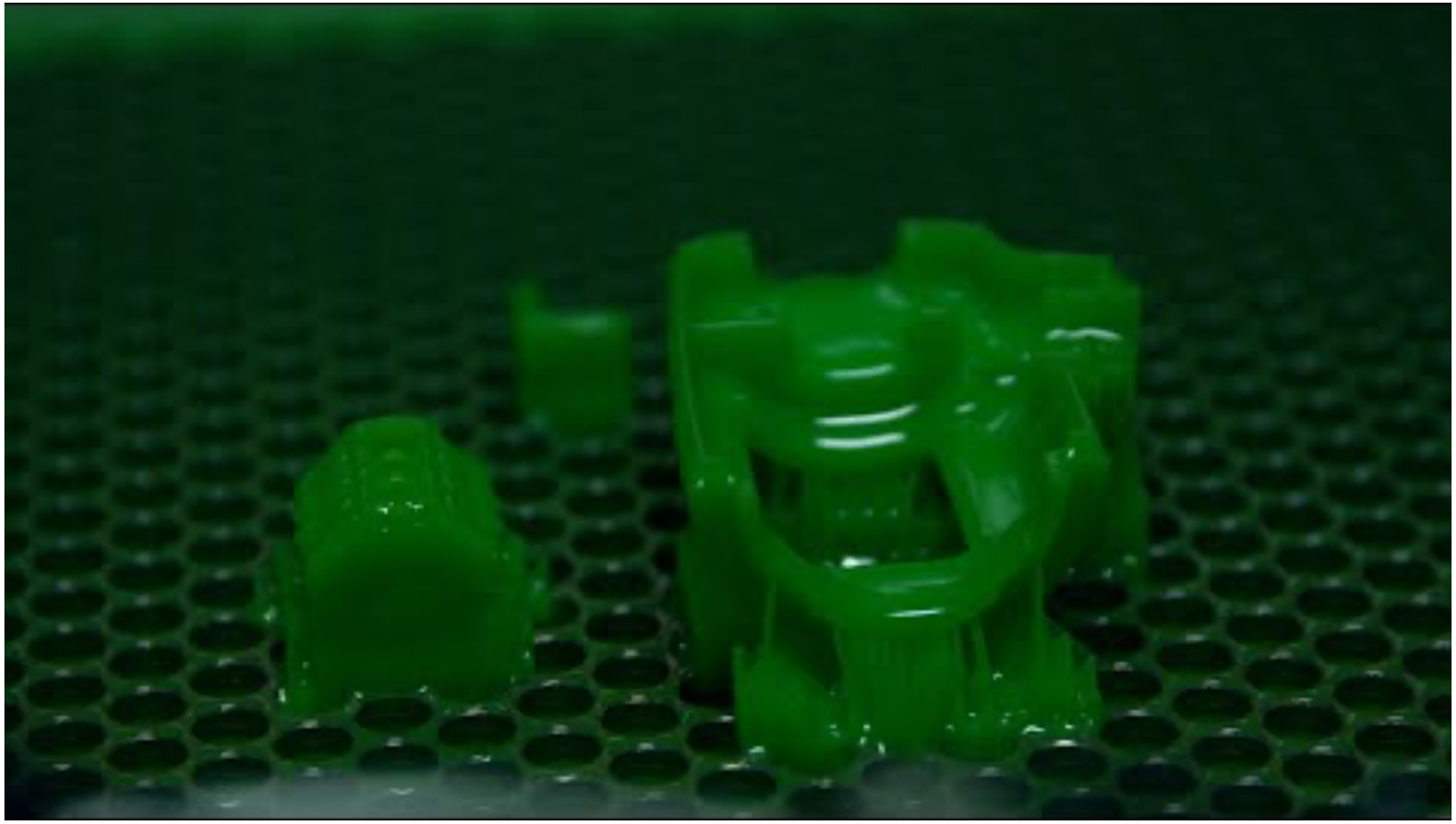
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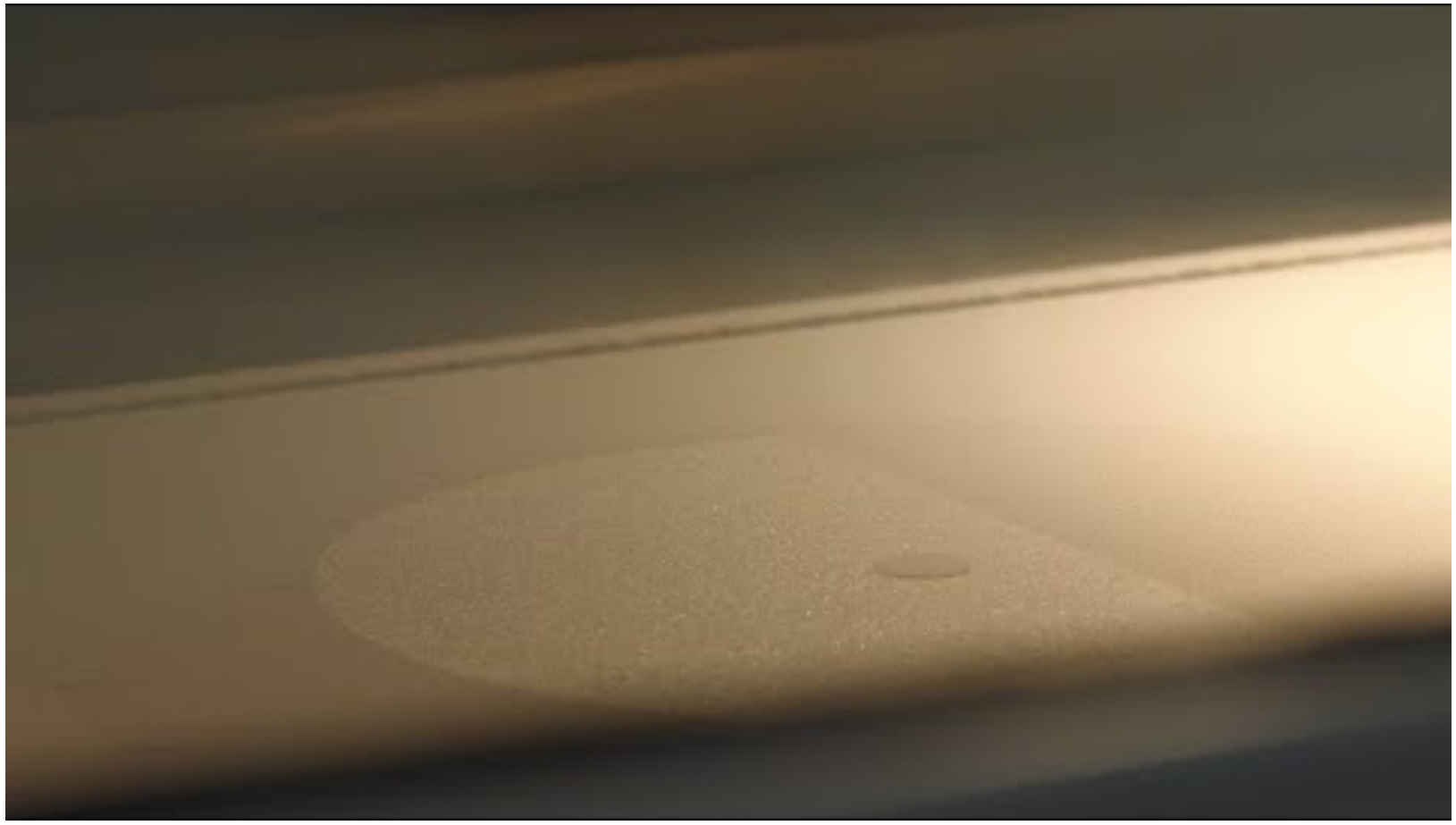
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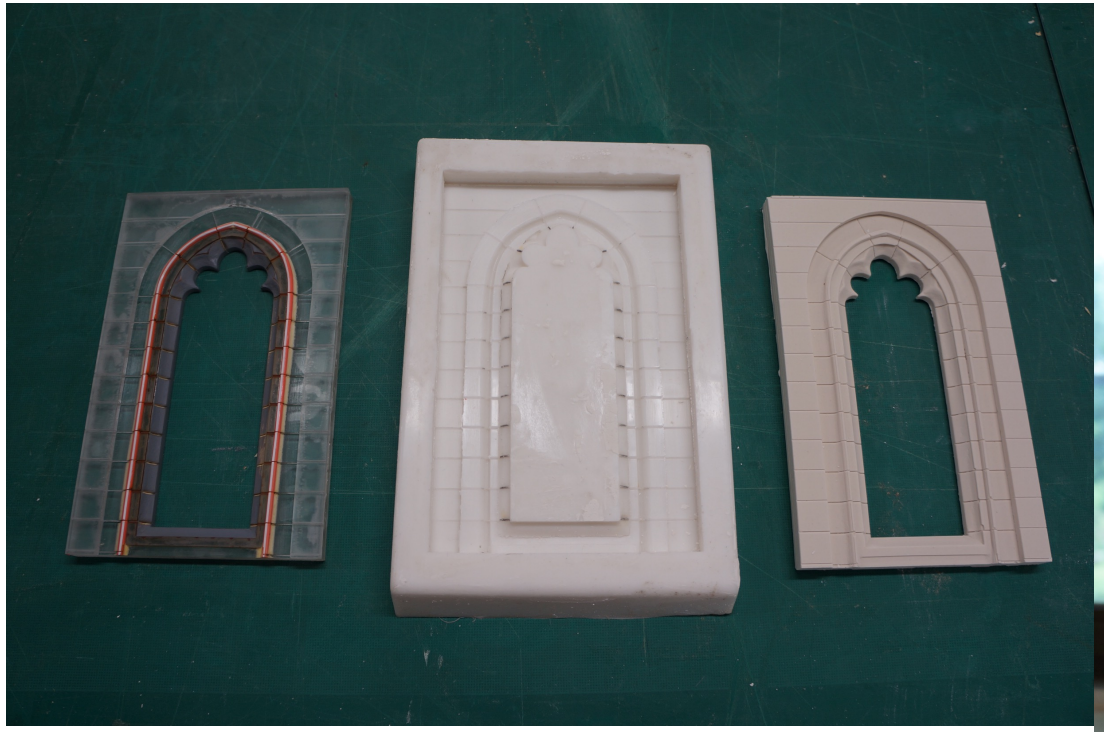
Other Tricks: Casting with Digital Molds

The Process:

1. 3D print or CNC a mold
2. Pour plaster or concrete
3. Get heavy, realistic pieces

Why?

Adds weight and texture that plastic can't give





https://b15.humanities.manchester.ac.uk/?tag=stone-plaster

Other Tricks: Kerf Bending

Making plywood bendable:

1. Laser cut slits in straight sheet

2. Material becomes flexible

3. Bends into curves







Part 2. Model Scale

Think Hybrid

Always combine techniques!

Build in layers:

1. Base → CNC terrain
2. Walls → Laser cut
3. Roof → 3D printed
4. Trees → 3D printed
5. Details → Cast plaster

Renzo Piano:

"CNC for site, laser for walls, SLA for trees."



https://formlabs.com/blog/3d-printing-architectural-models/

Think Hybrid

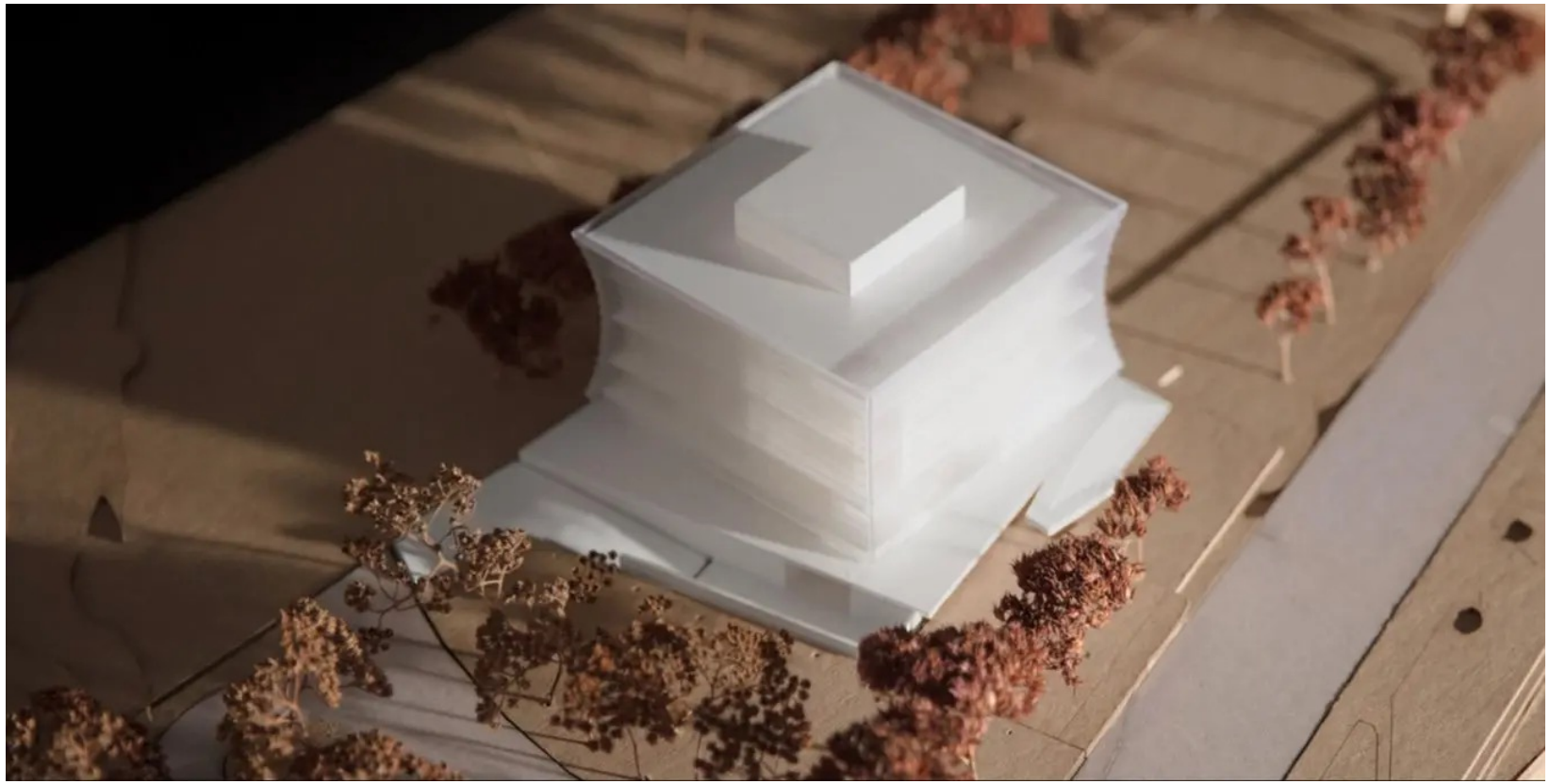
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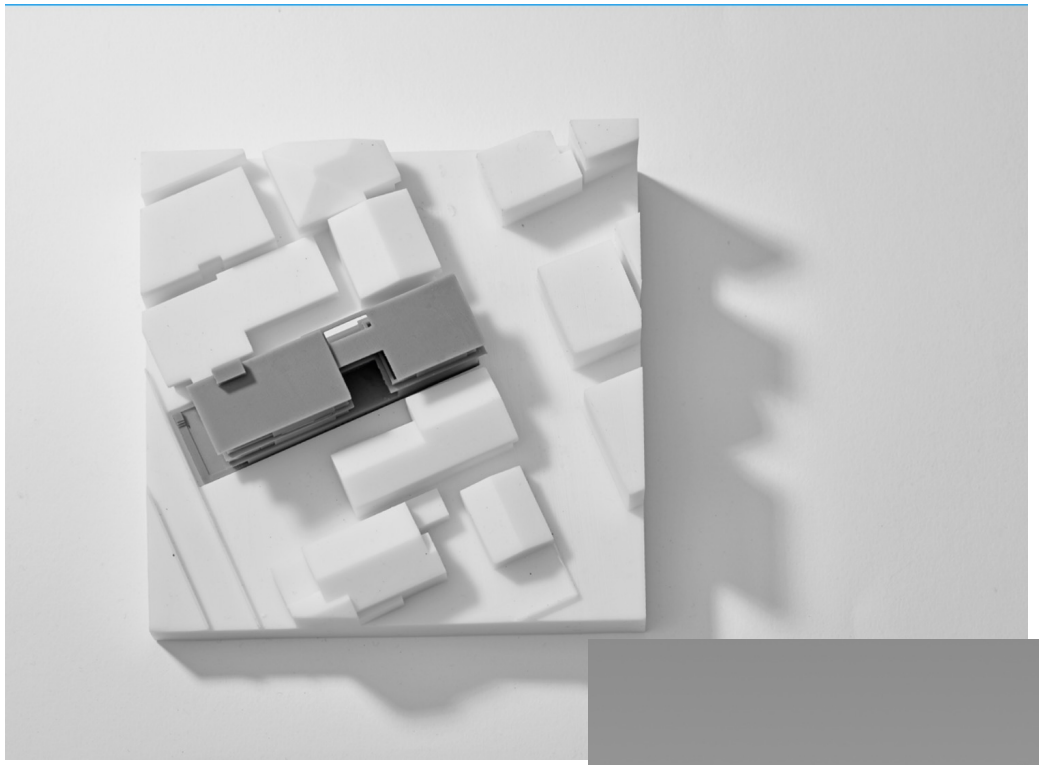
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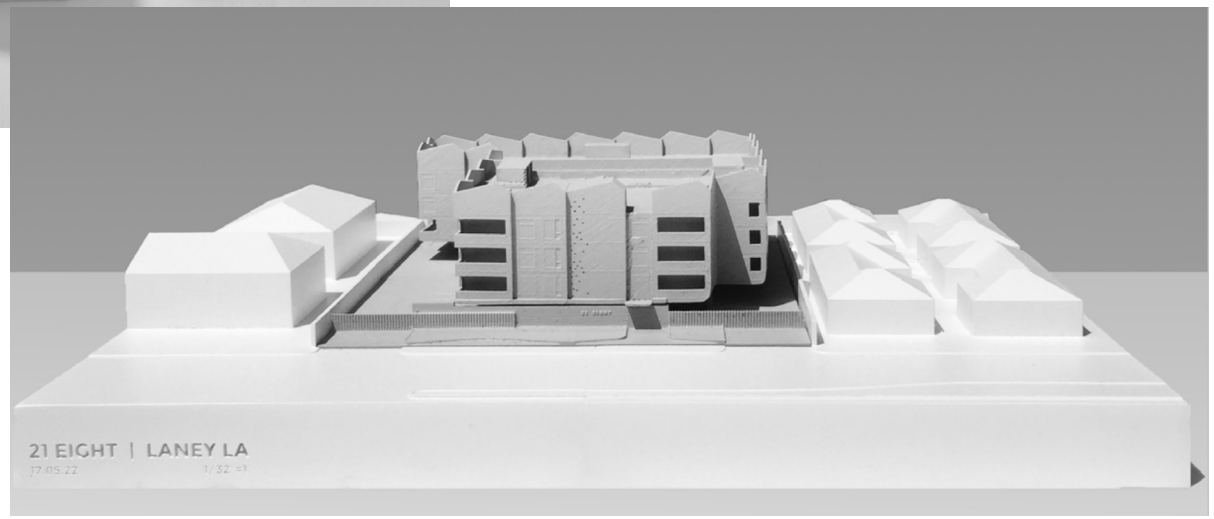
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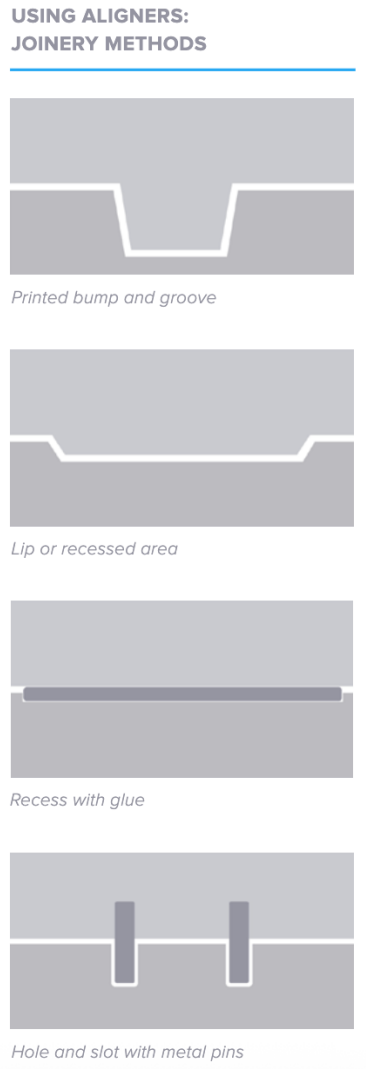
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This model from LaneyLA was printed on a Form 2 with White Resin.



Think Hybrid

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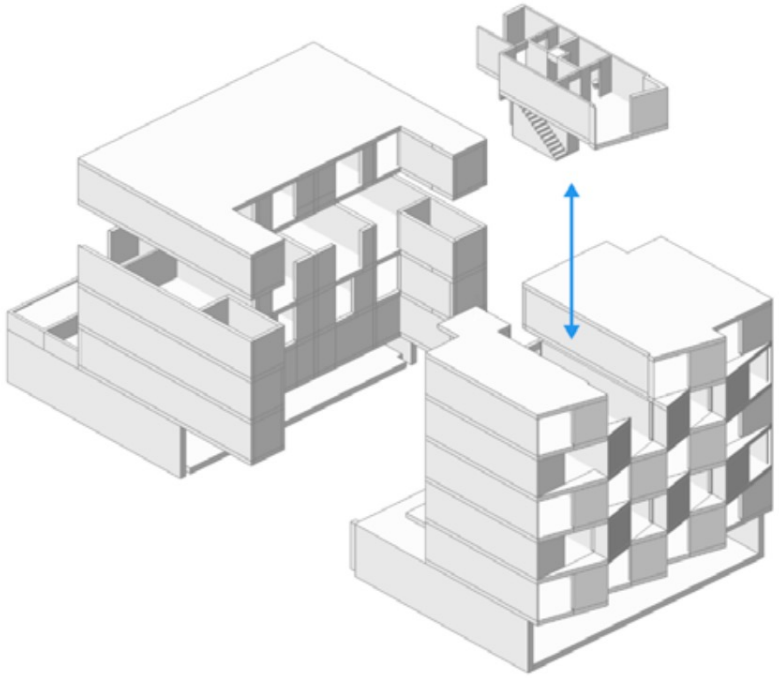
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Model by Stanley Saitowitz | Natoma Architects Inc.

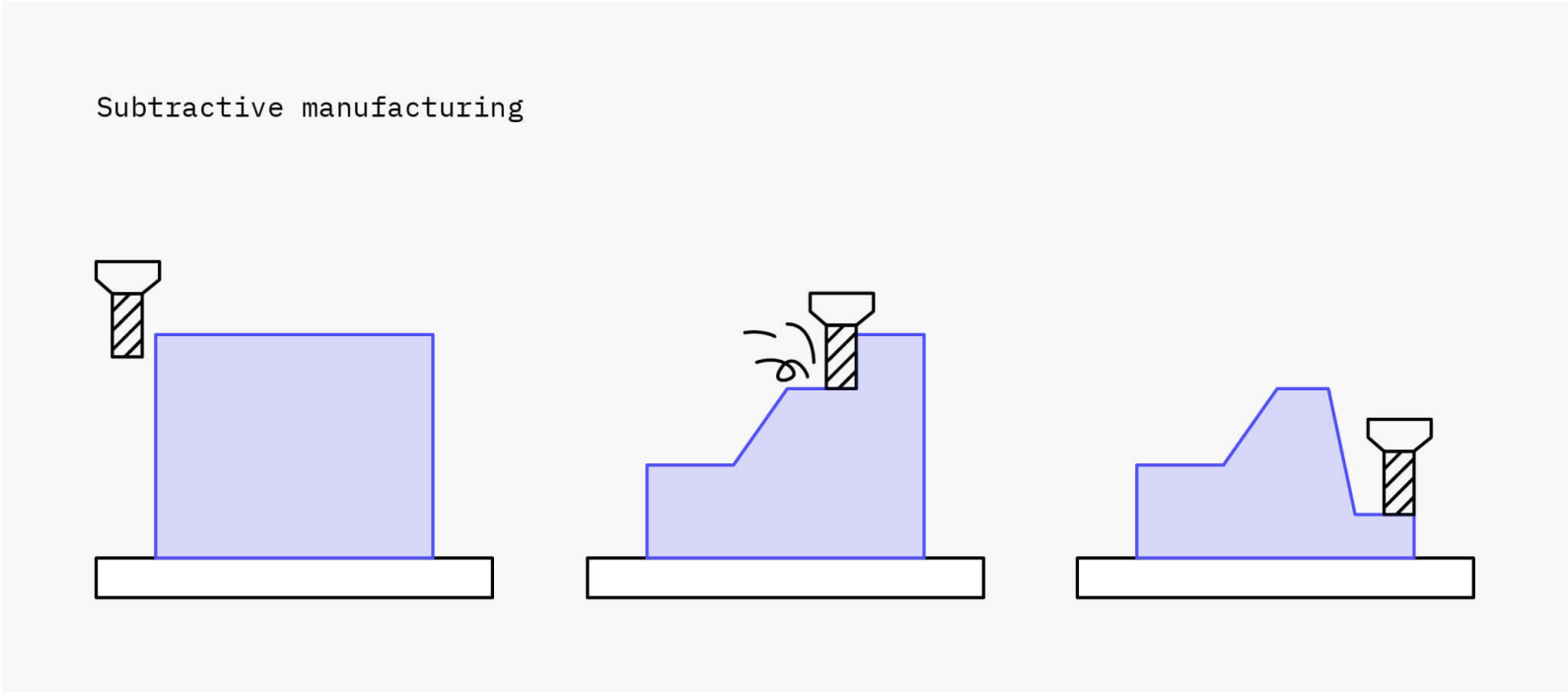


Since each housing unit followed the same design, it made sense to simply print one removable unit that would allow the client to understand the generic unit typology.

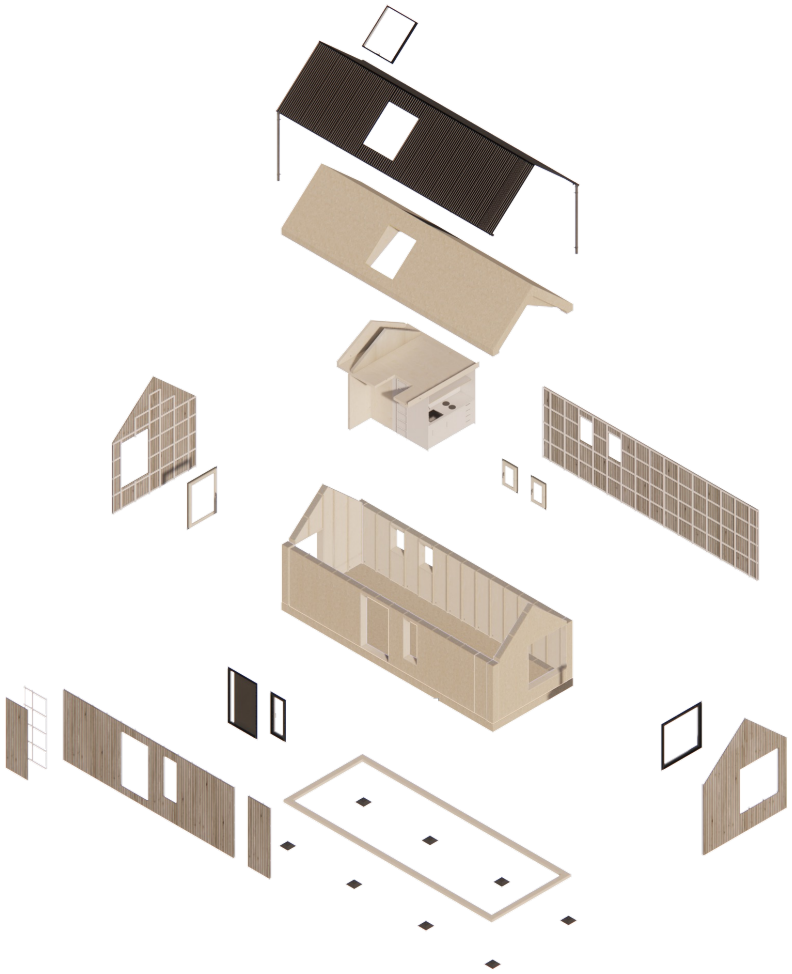
Part 3. Building Scale: Subtractive

Subtractive

CNC routers, waterjet cutters, and robotic mills cut standard materials (plywood, steel, stone, aluminum) into mass-customized components. Digital model → nesting → CNC cut → assembly.



Subtractive - Wood



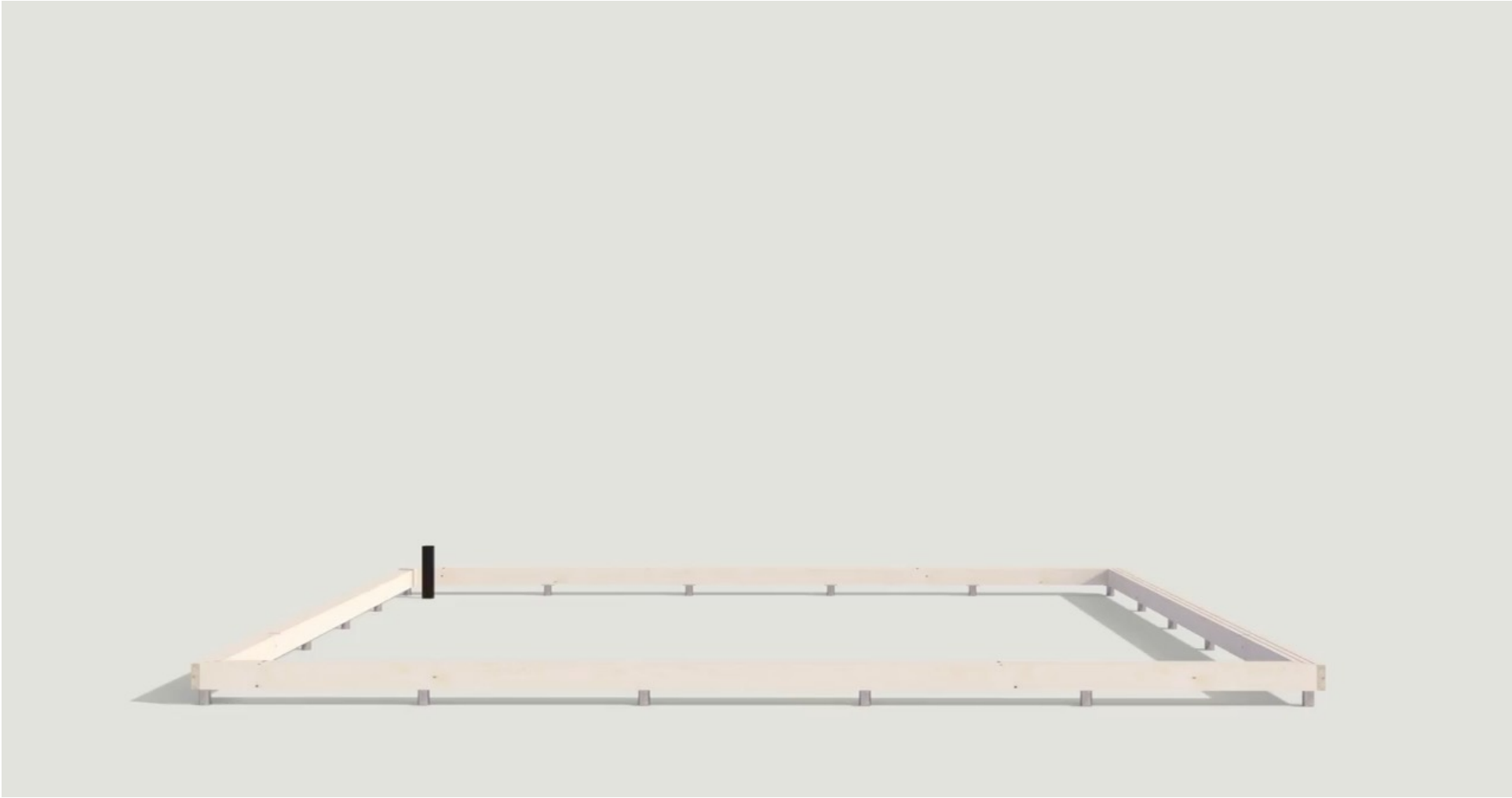
WikiHouse

https://www.wikihouse.cc/

Subtractive - Wood

Mass Customization

WikiHouse



https://www.wikihouse.cc/

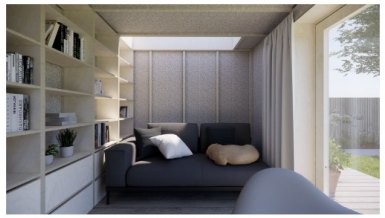
Subtractive - Wood

Mass Customization

WikiHouse









Garden studio

£18,000-£22,000

Excluding installation, site works and VAT. Estimate only, based on example specification.

Details

Upfront carbon cost	-0.4tCO_2e
Internal floor area	11m²
Suitable for	Any mild climate
Blocks	Uses mostly custom blocks
Last updated	December 3, 2024

Resources

- Download 3D model
- Download bill of materials
- Download cutting files
- Download assembly manual
- Report an issue or suggest an improvement

n extra room in the garden that you can uild for yourself.

more and more of us, home is no longer just the place where we live.

Get a quote

https://www.wikihouse.cc/

Subtractive - Wood

Mass Customization



WALL-S10+9R

w318 l918 h1482

A gable end wall block that works with a 10 degree mono-pitched roof.



WALL-S10+8R

w318 l918 h1376

A gable end wall block that works with a 10 degree mono-pitched roof.



WALL-S10+7R

w318 l918 h1271

A gable end wall block that works with a 10 degree mono-pitched roof.



WALL-S10+6R

w318 l918 h1165

A gable end wall block that works with a 10 degree mono-pitched roof.



WALL-S10+6

w318 l600 h1109

A gable end wall block that works with a 10 degree mono-pitched roof.



WALL-S10+5R

w318 l918 h1060

A gable end wall block that works with a 10 degree mono-pitched roof.



WALL-S10+4

w318 l600 h900

A gable end wall block that works with a 10 degree mono-pitched roof.

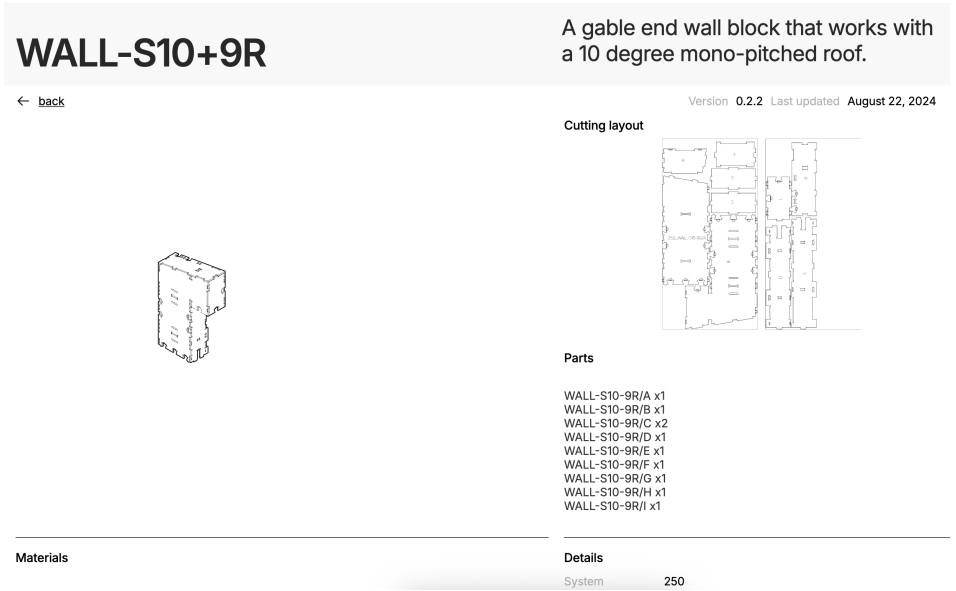


WALL-S10+3

w318 l600 h790

A gable end wall block that works with a 10 degree mono-pitched roof.

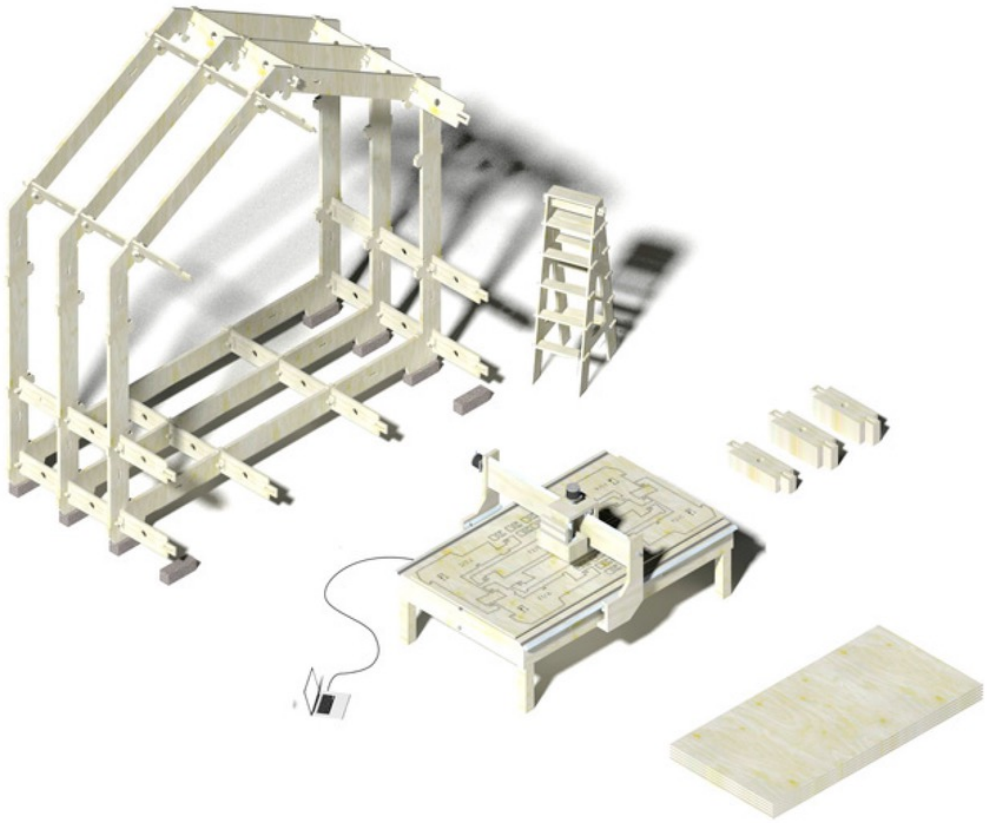
WikiHouse



https://www.wikihouse.cc/

Subtractive - Wood

Mass
Customization





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Subtractive - Wood

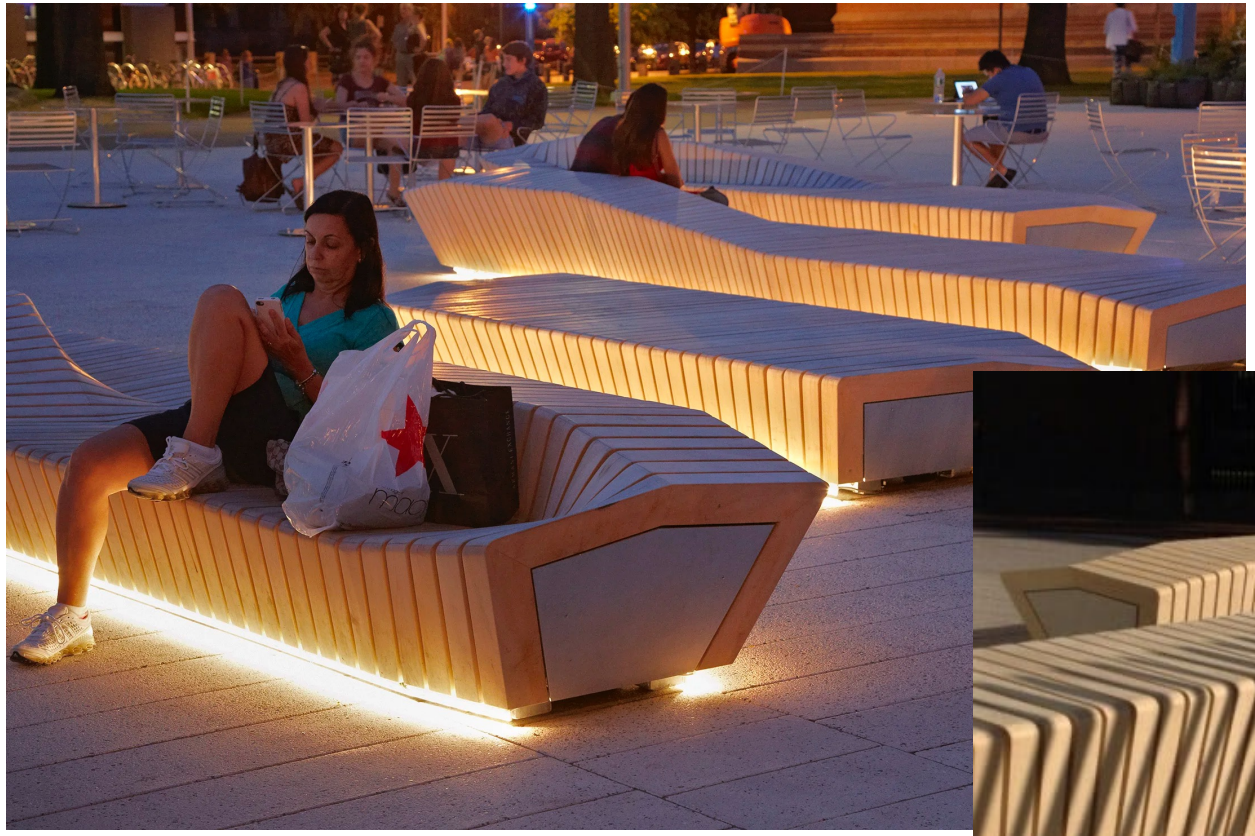
Mass
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WikiHouse



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Subtractive - Wood





Harvard Plaza
Benches
Stoss

Subtractive - Wood

Harvard Plaza
Benches
Stoss





Subtractive - Wood



Bamboo Craft
Village
Archi-Union

Subtractive - Wood



Bamboo Craft Village
Archi-Union

Subtractive - Wood

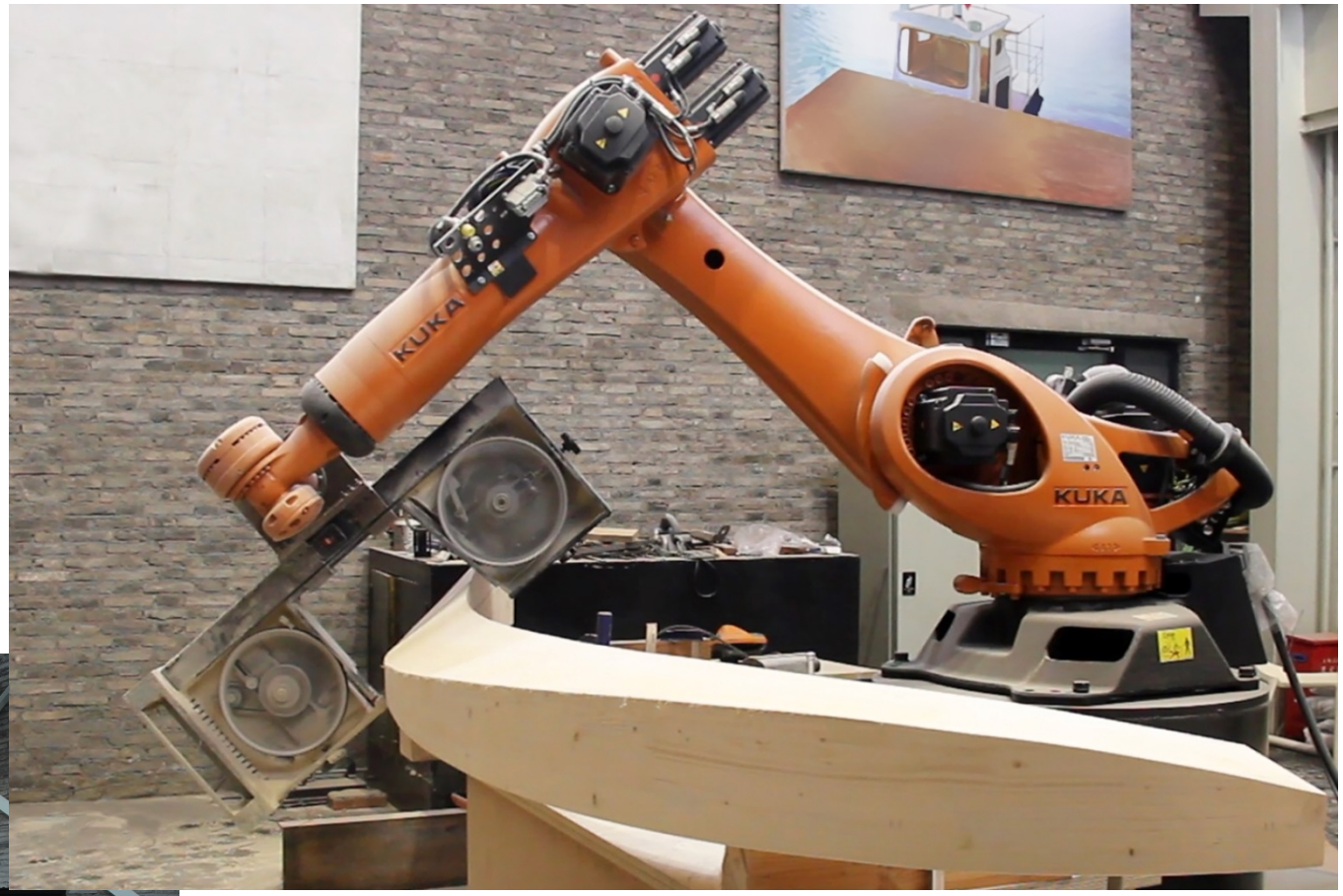






Bamboo Craft
Village
Archi-Union

Subtractive - Wood

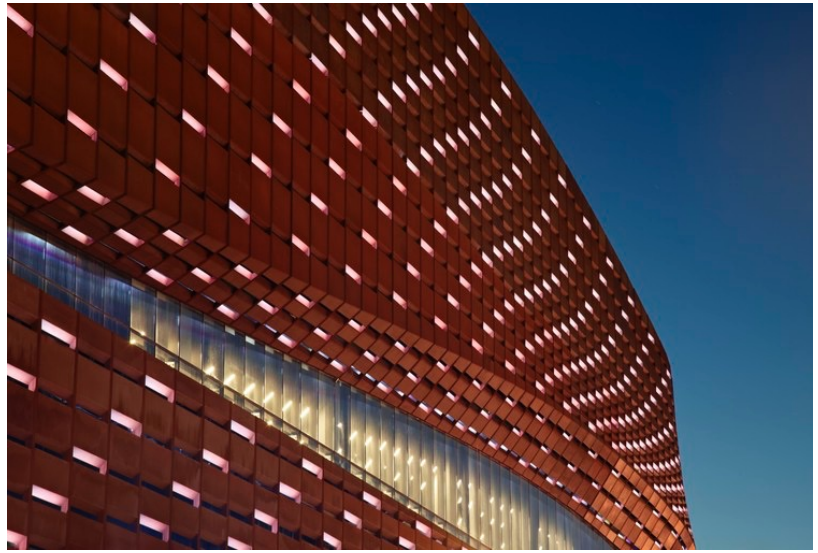




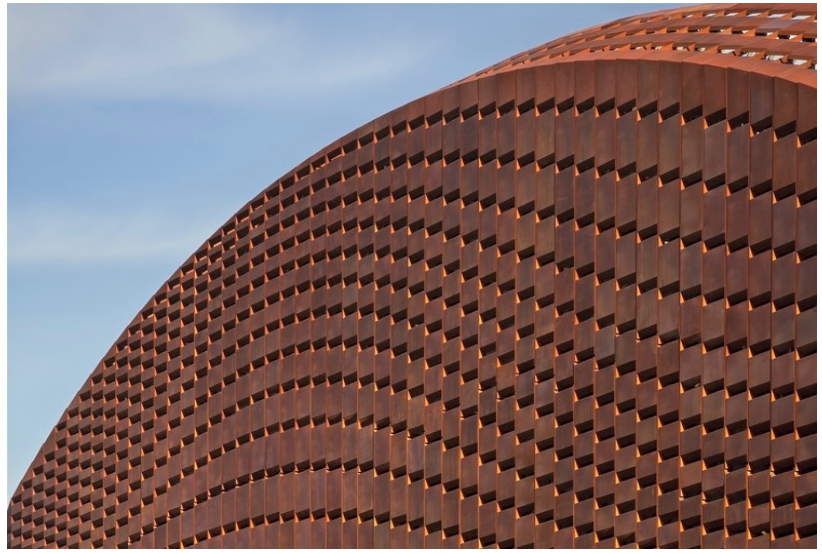
Bamboo Craft
Village
Archi-Union

Subtractive - Metal









Barclays Center
SHoP Architects

Subtractive - Metal







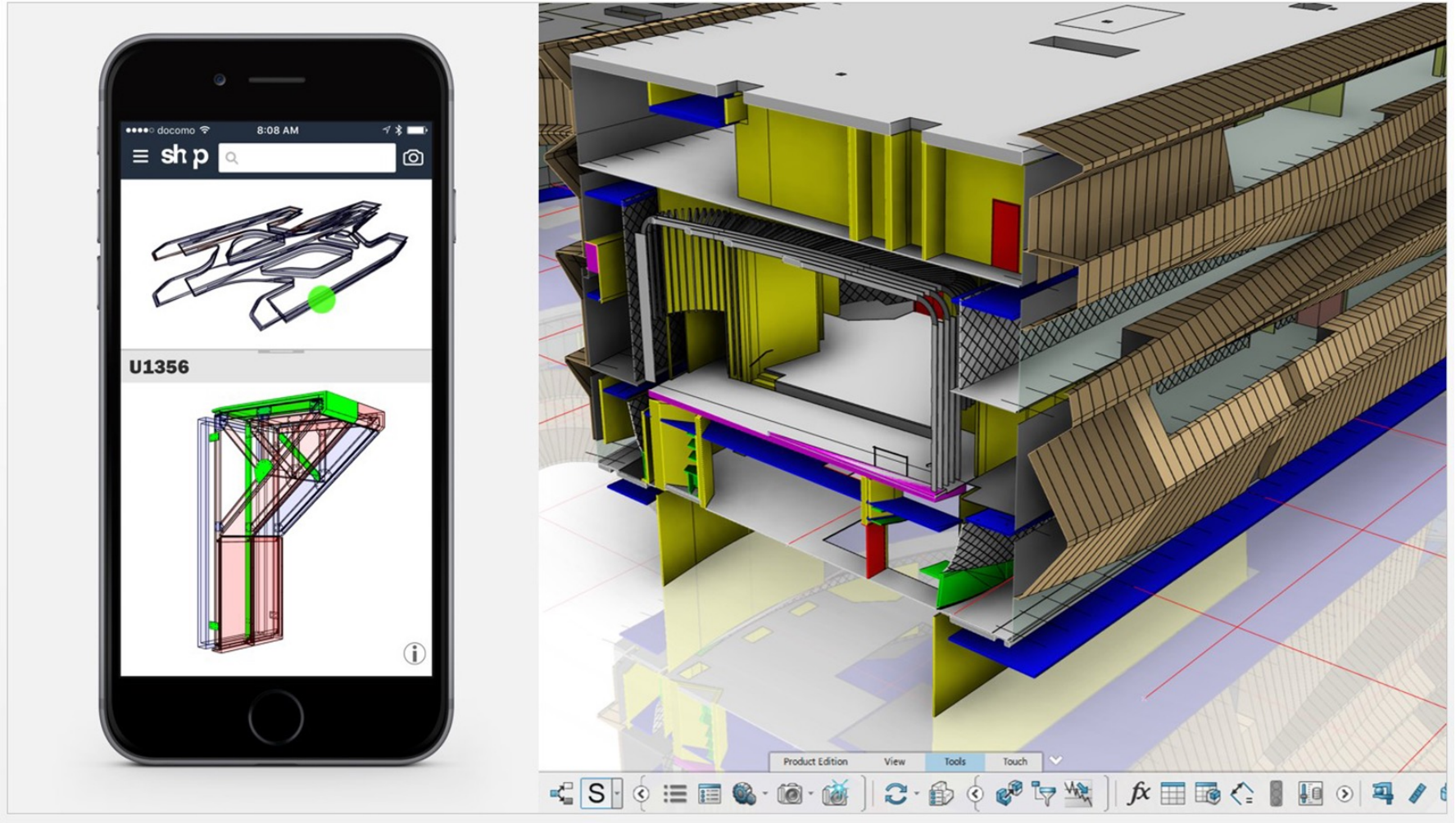
Barclays Center
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Subtractive - Metal



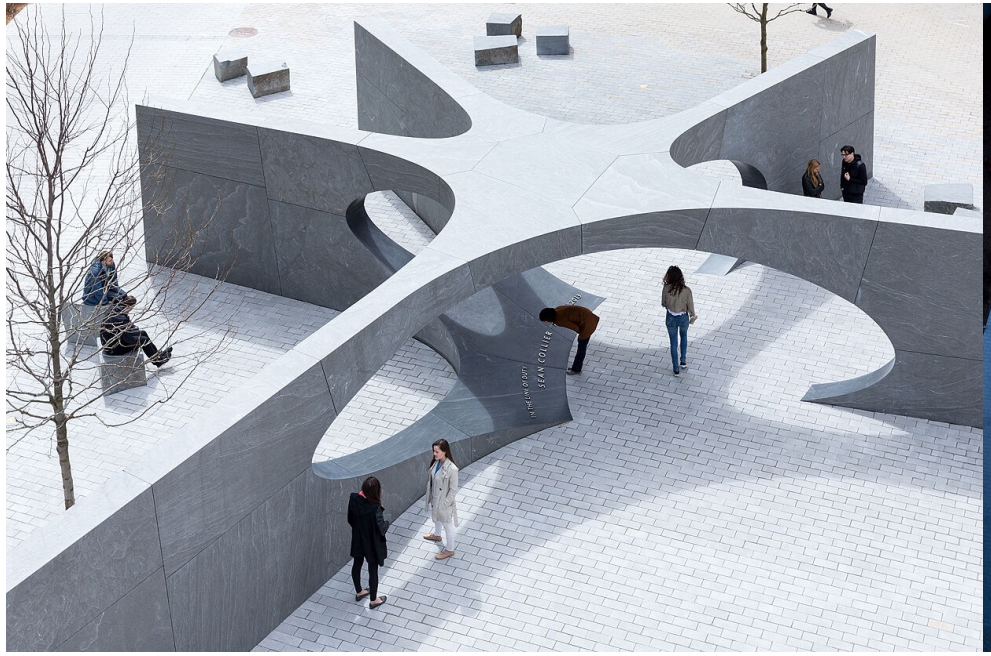
Botswana
Innovation Hub
SHoP Architects

Subtractive - Metal



Botswana
Innovation Hub
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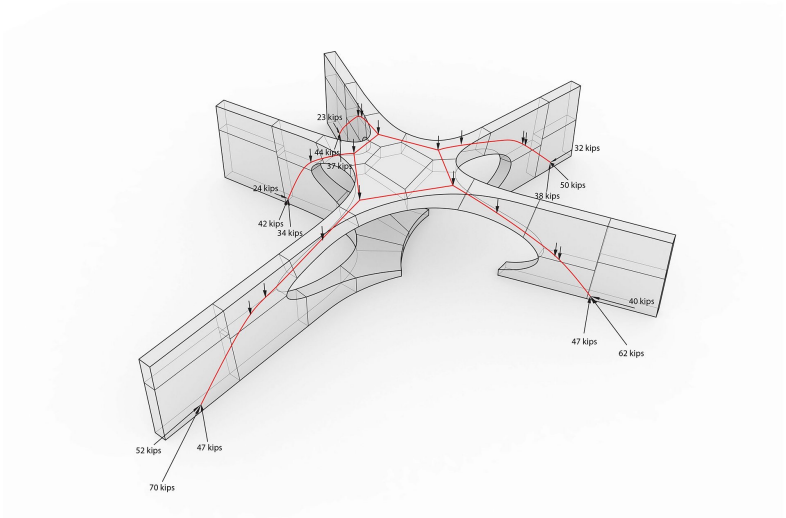
Subtractive - Stone

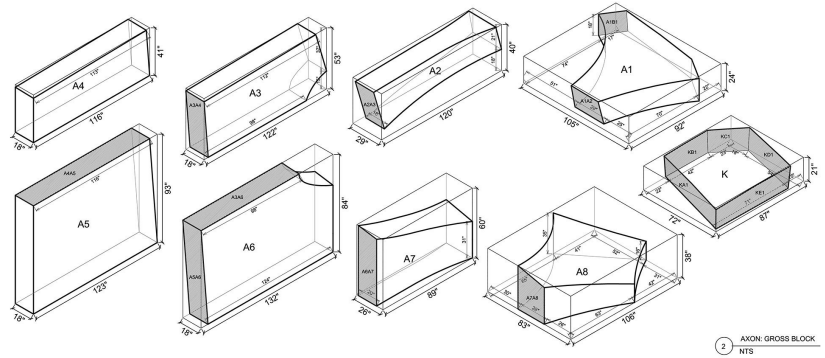


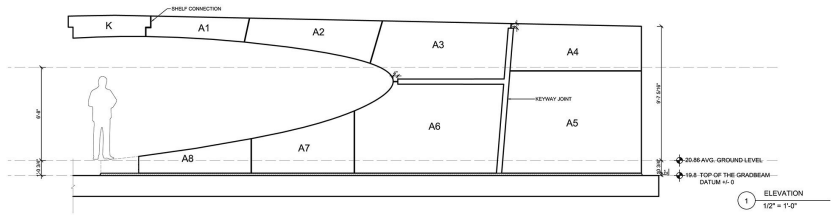


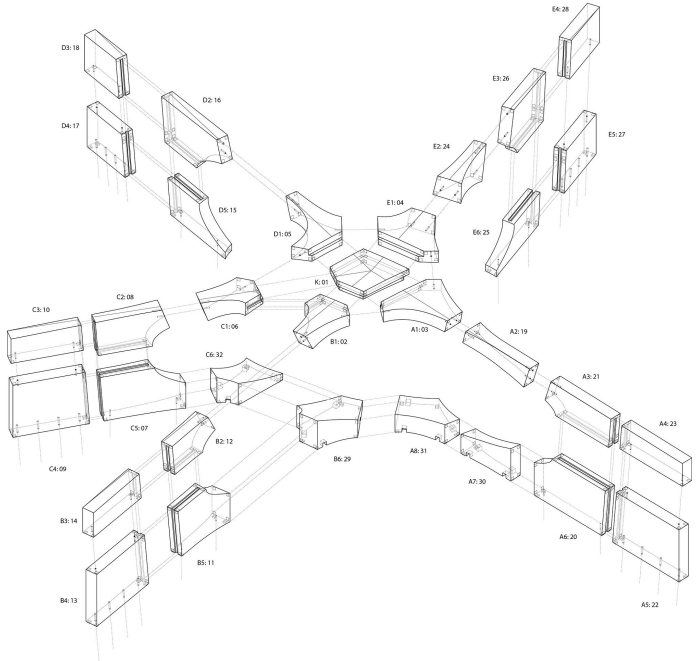
Collier Memorial
Höweler+Yoon

Subtractive - Stone



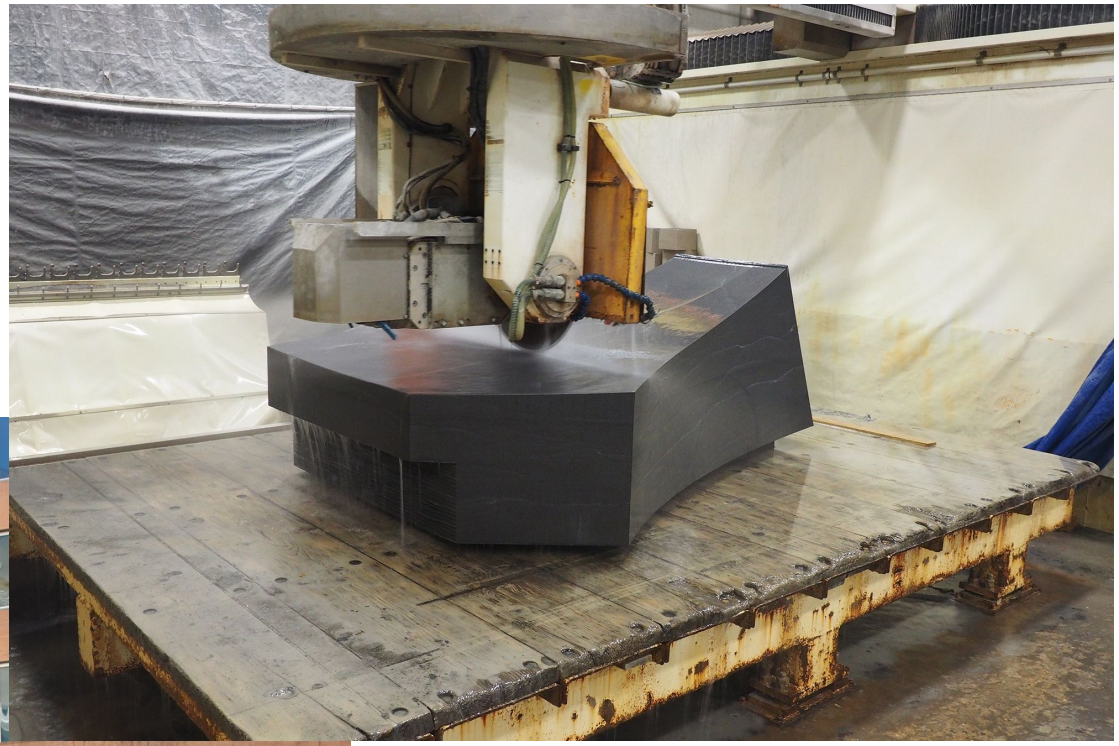






Collier Memorial
Höweler+Yoon

Subtractive - Stone





Collier Memorial
Höweler+Yoon

Subtractive - Stone

Collier Memorial
Höweler+Yoon





Subtractive - Stone



Memorial to
Enslaved Laborers
Höweler+Yoon

Subtractive - Stone

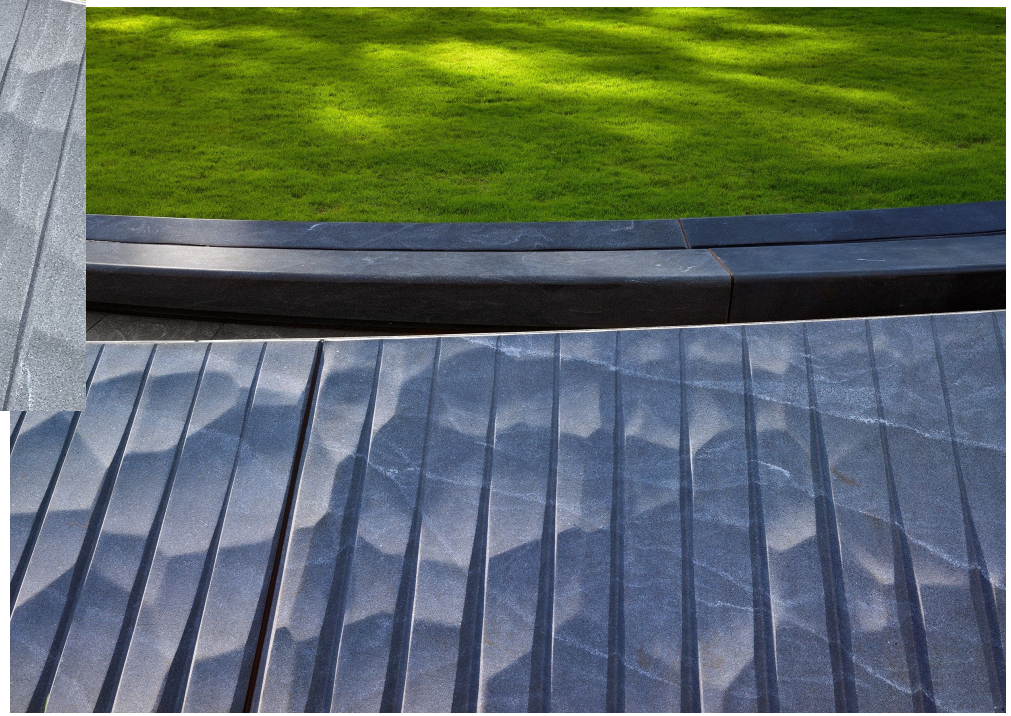




Memorial to
Enslaved Laborers
Höweler+Yoon

Subtractive - Stone





Memorial to
Enslaved Laborers
Höweler+Yoon

Subtractive - Stone



Memorial to
Enslaved Laborers
Höweler+Yoon

Part 4. Building Scale: Additive

Part 4. Building Scale: Subtractive

Additive – Concrete

Pros:

- Fast construction (walls in hours, not days)
- Complex curves cost the same as straight walls
- Less formwork = less waste
- Can print on-site
- Strong and durable like traditional concrete

Cons:

- Limited to walls (can't print floors/roofs yet)
- Still needs reinforcement for structure
- Nozzle size limits detail
- Surface has visible layer lines
- Requires special concrete mix (can't use regular concrete)



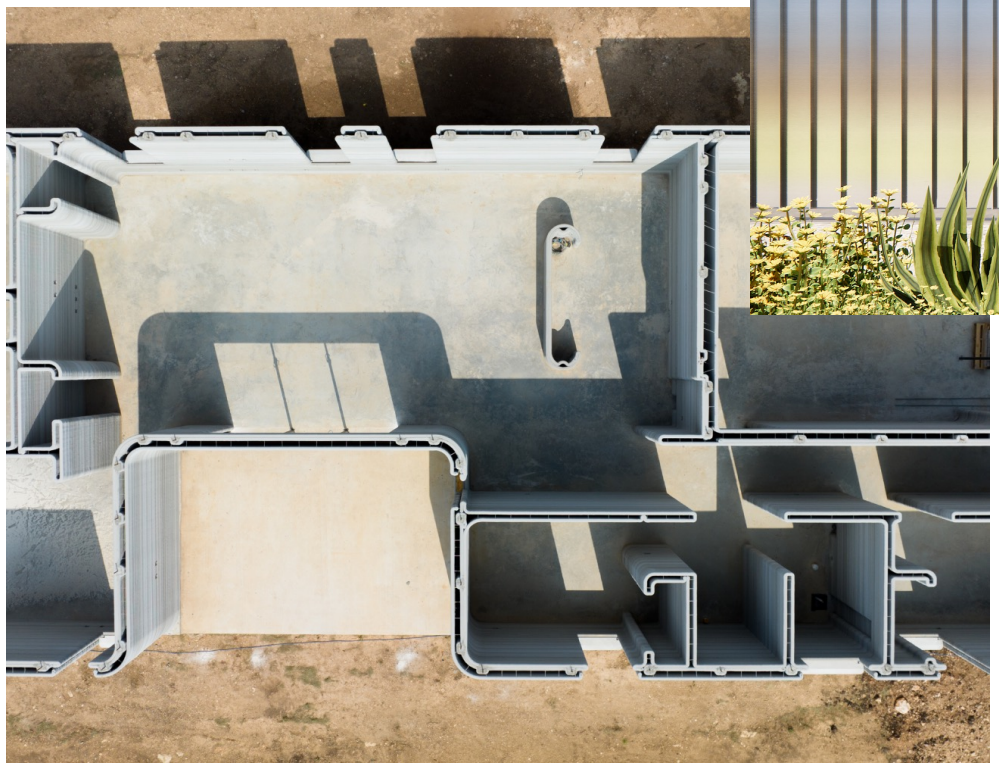
https://iconbuild.com/

Additive – Concrete

Wolf Ranch: 100 homes (largest 3D printed community)

House Zero: First permitted 3D printed house in US



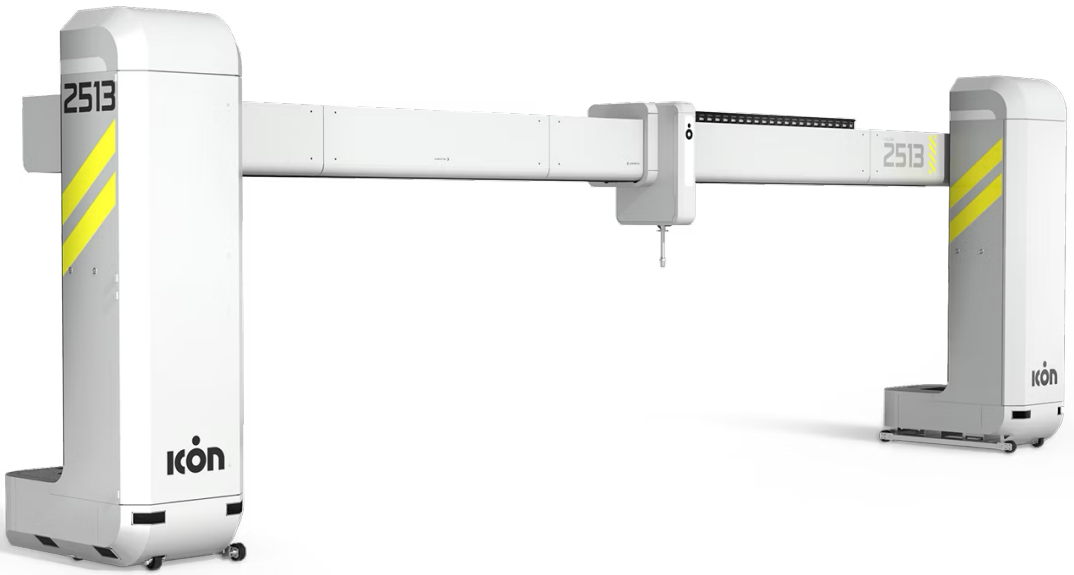


ICON

https://iconbuild.com/

Additive – Concrete



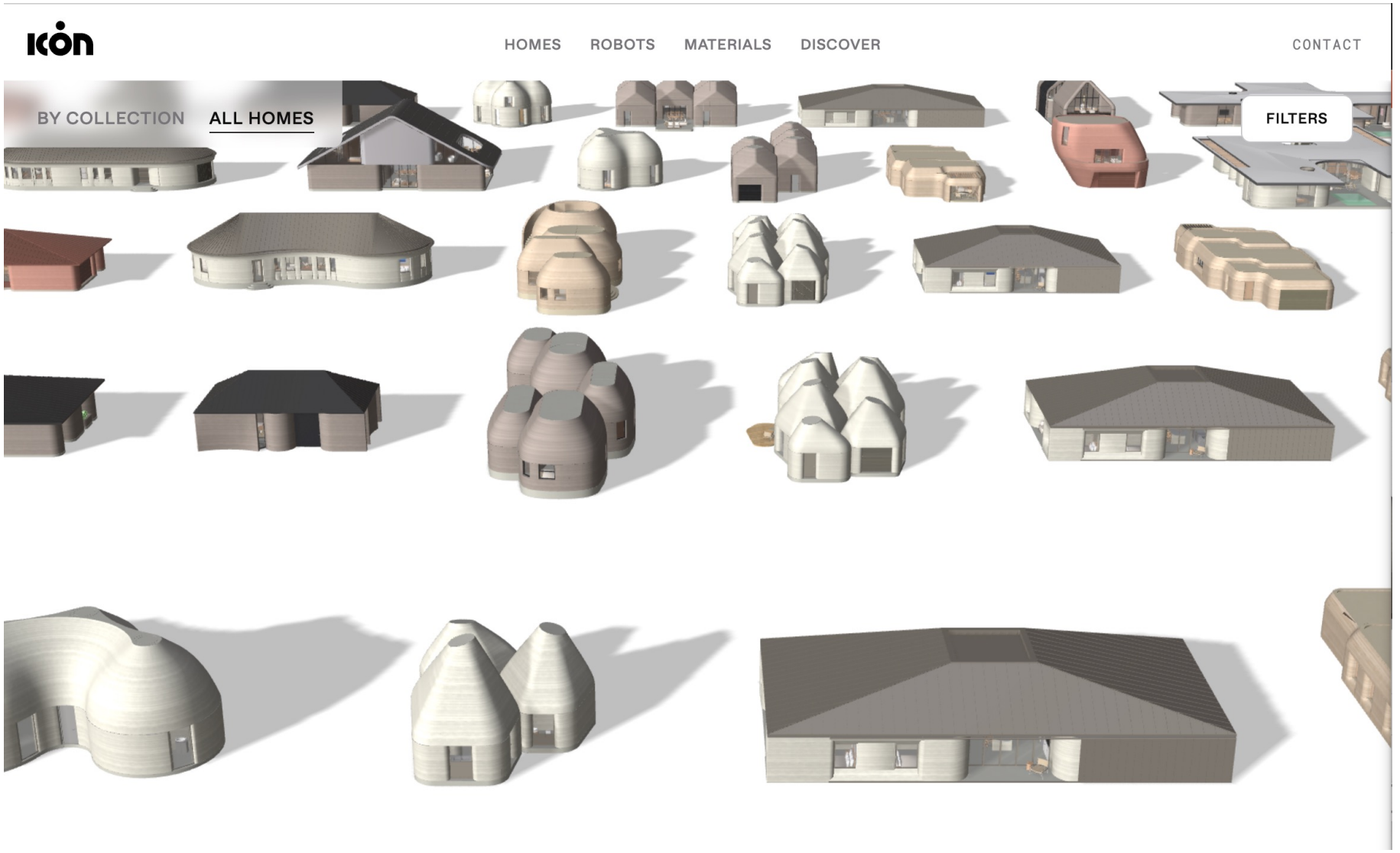


ICON

https://iconbuild.com/

Additive – Concrete

ICON



https://iconbuild.com/

Additive – Concrete

STORM

Storm Cell 2/2



ICON

STORM	BED	BATH	FLOORS	LIVING SPACE	GROSS FLOOR AREA
Storm Cell 2/2	2	2	1	2,093 ft²	1,597 ft²

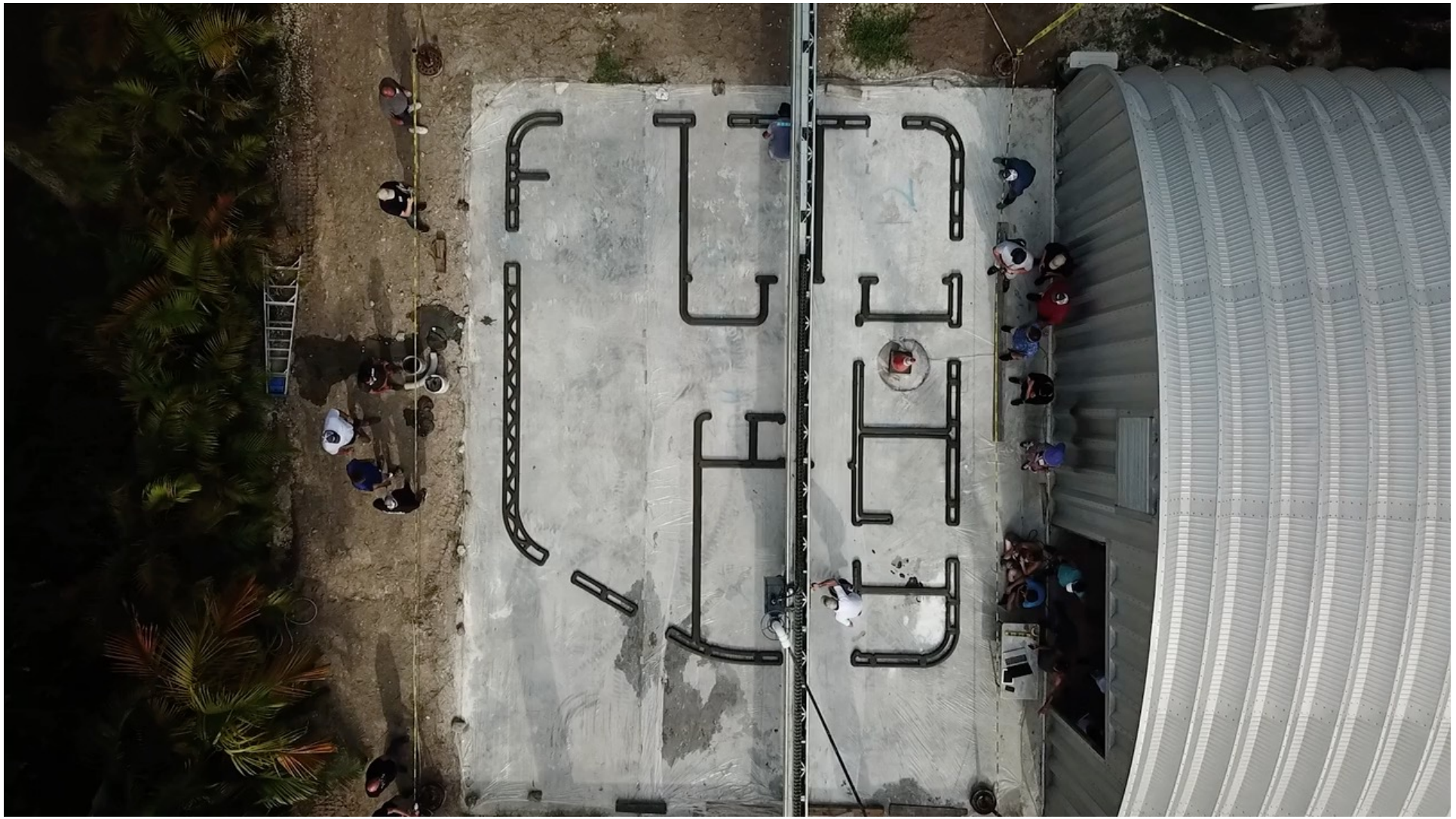
ESTIMATED BUILD COST	APPROX. BUILD TIME	DESIGNED BY
$445K - $515K	Coming Soon	BIG

I'M INTERESTED

https://iconbuild.com/

Additive – Concrete

COBOD



https://cobod.com/

Additive – Concrete

COBOD



https://cobod.com/

Additive – Concrete

COBOD



https://cobod.com/

Additive – Earth/Clay

Pros:

- Eco-friendly (lowest carbon footprint)
- Uses local soil - literally site material
- Biodegradable and non-toxic
- Excellent thermal mass (stays cool/warm naturally)
- Breathable walls (healthy indoor air)
- Free or nearly free material

Cons:

- Not waterproof without treatment
- Limited structural strength (mostly compression)
- Needs protection from rain during printing
- Slower printing than concrete
- Not approved by building codes in most places yet





Additive – Earth/Clay



TECLA House
WASP

https://www.3dwasp.com/en/3d-printed-house-tecla/

Additive – Earth/Clay



TECLA House
WASP

https://www.3dwasp.com/en/3d-printed-house-tecla/

Additive – Earth/Clay



TECLA House
WASP

https://www.3dwasp.com/en/3d-printed-house-tecla/

Additive – Earth/Clay

TECLA House
WASP





https://www.3dwasp.com/en/3d-printed-house-tecla/

Additive – Metal



MX3D Bridge
Joris Laarman Lab
+ Arup

https://mx3d.com/case/mx3d-bridge/

Additive – Metal



MX3D Bridge
Joris Laarman Lab
+ Arup

https://mx3d.com/case/mx3d-bridge/

Additive – Metal

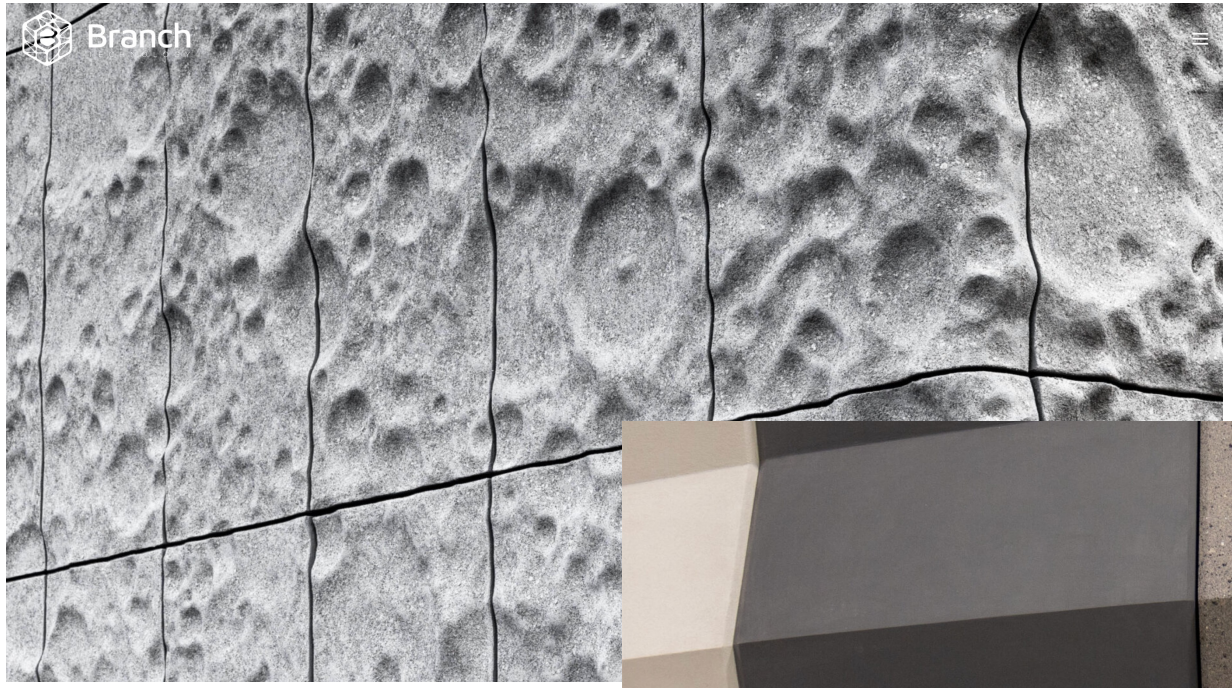


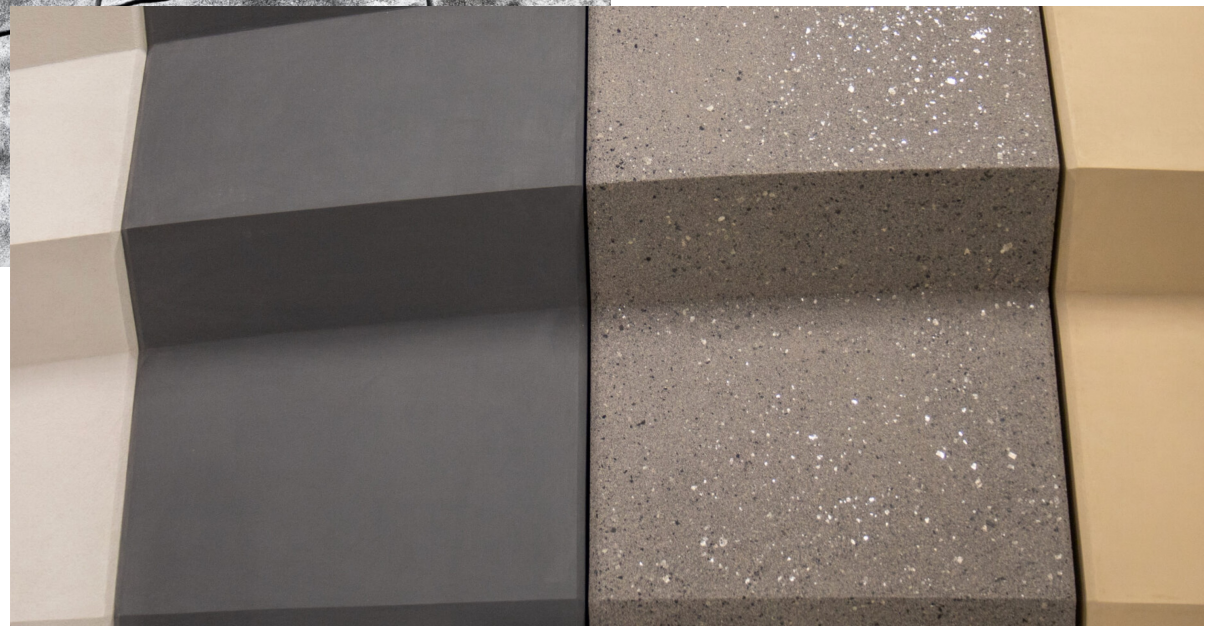
MX3D Bridge
Joris Laarman Lab
+ Arup

https://mx3d.com/case/mx3d-bridge/

Additive – Plastic/Polymer





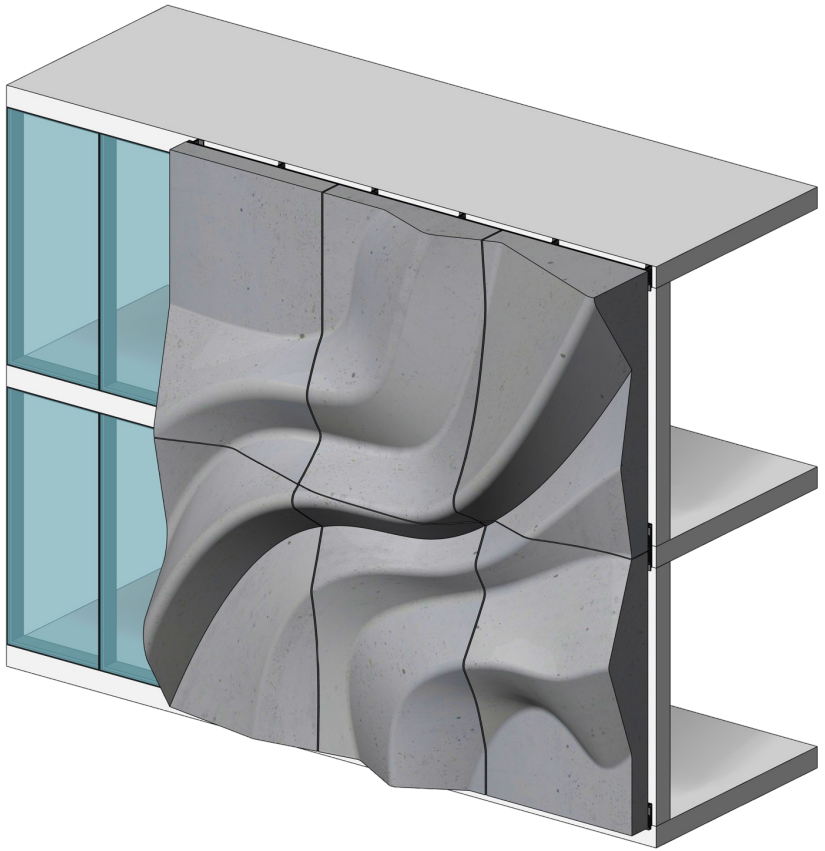


Branch Technology

https://branchtechnology.com/

Additive – Plastic/Polymer









Branch Technology

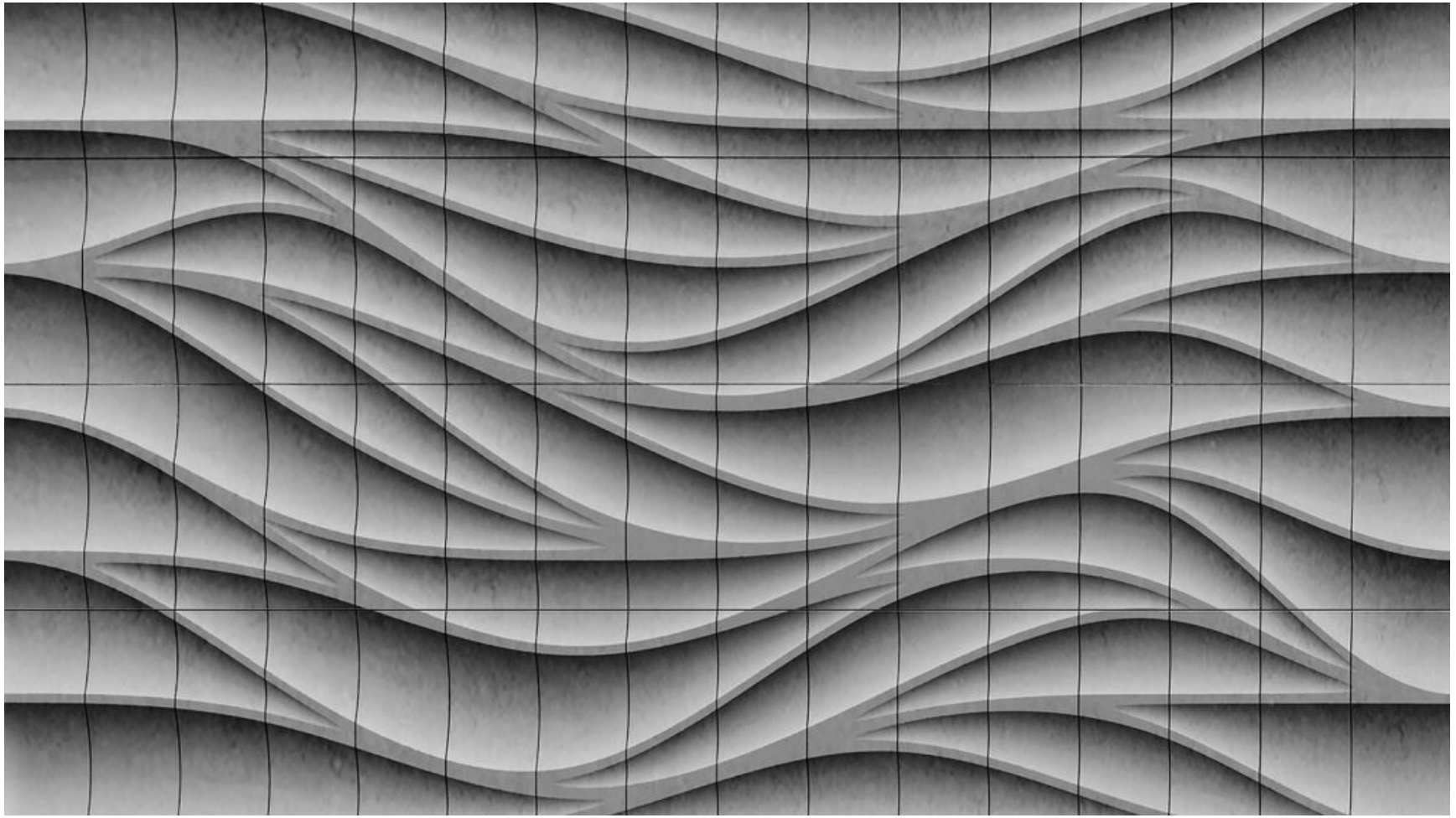
Tennessee Valley
Federal Credit Union

https://branchtechnology.com/

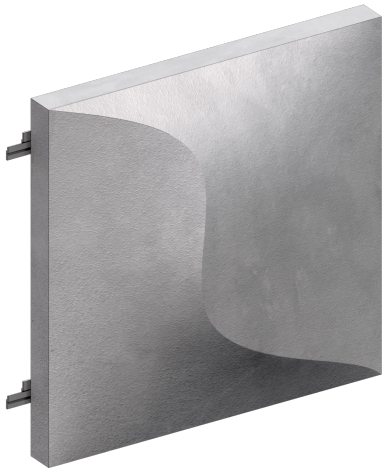
Additive – Plastic/Polymer



Branch Technology



Additive – Plastic/Polymer



Branch Technology



https://branchtechnology.com/

Additive – Plastic/Polymer





Branch Technology

https://branchtechnology.com/

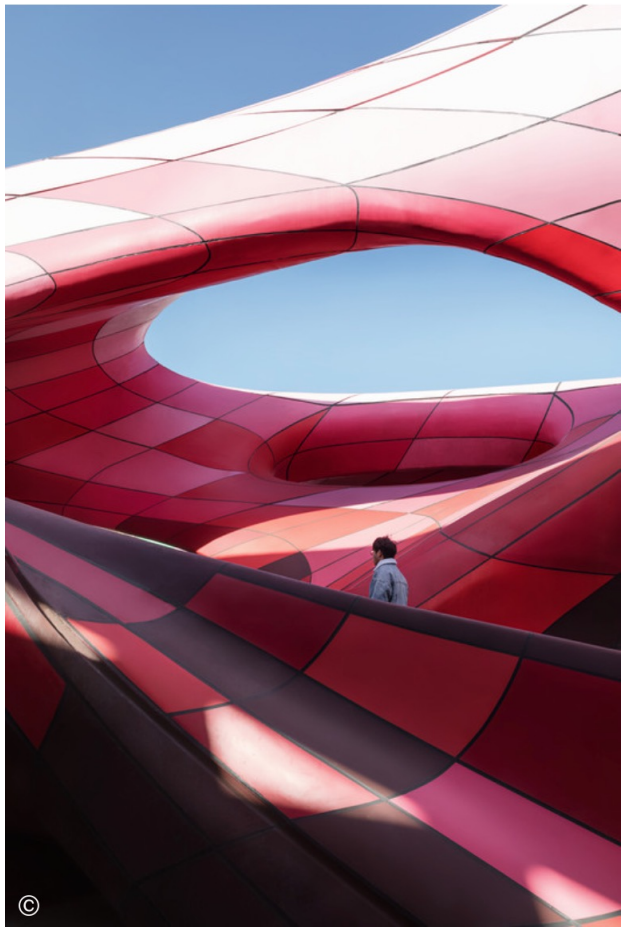
Additive – Plastic/Polymer

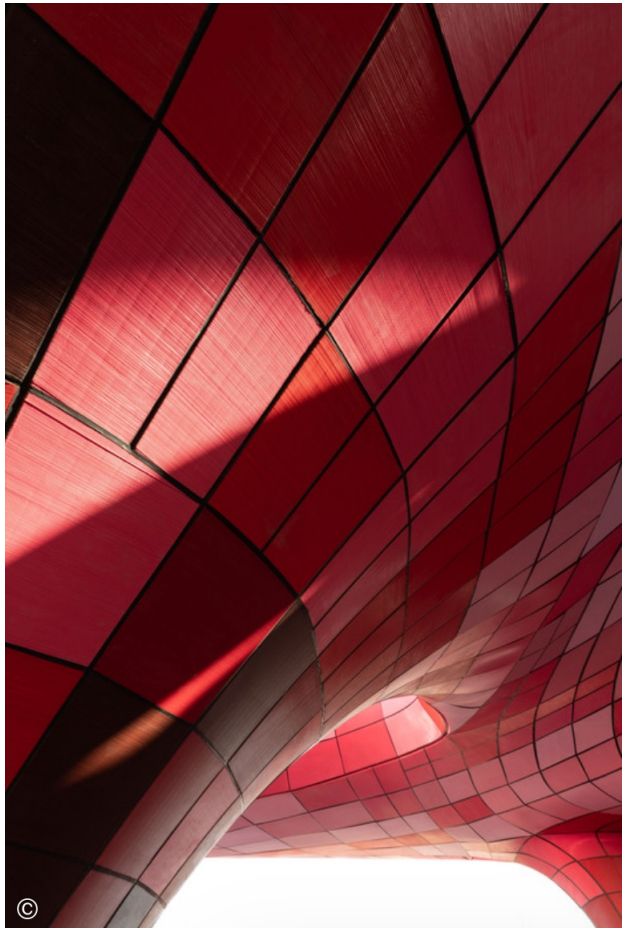


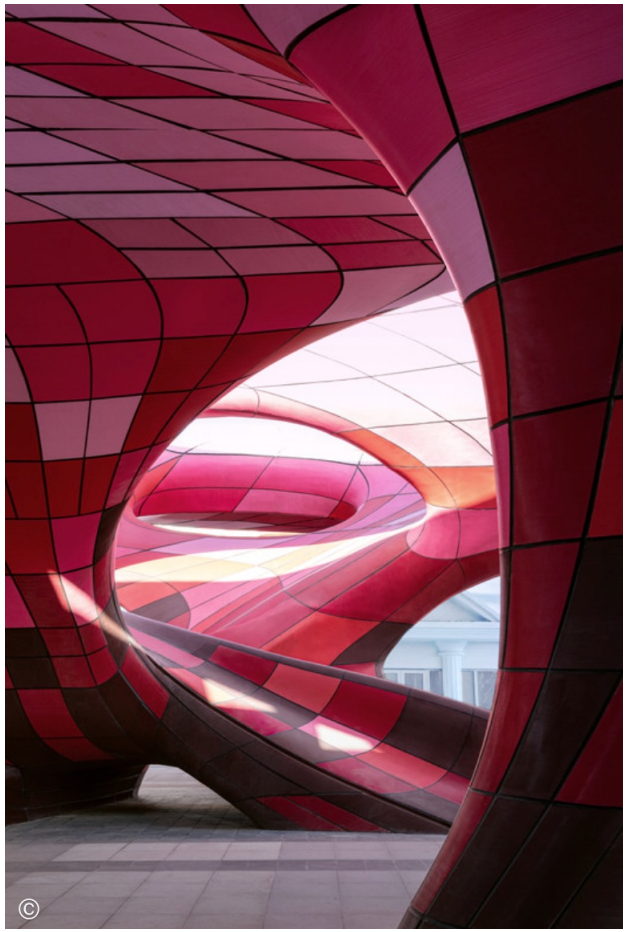
Nanjing Happy
Valley Pavilion
Archi-Union

Additive – Plastic/Polymer

Nanjing Happy Valley Pavilion
Archi-Union







Additive – Plastic/Polymer





Nanjing Happy Valley Pavilion
Archi-Union

Part 5. Building Scale: Formative

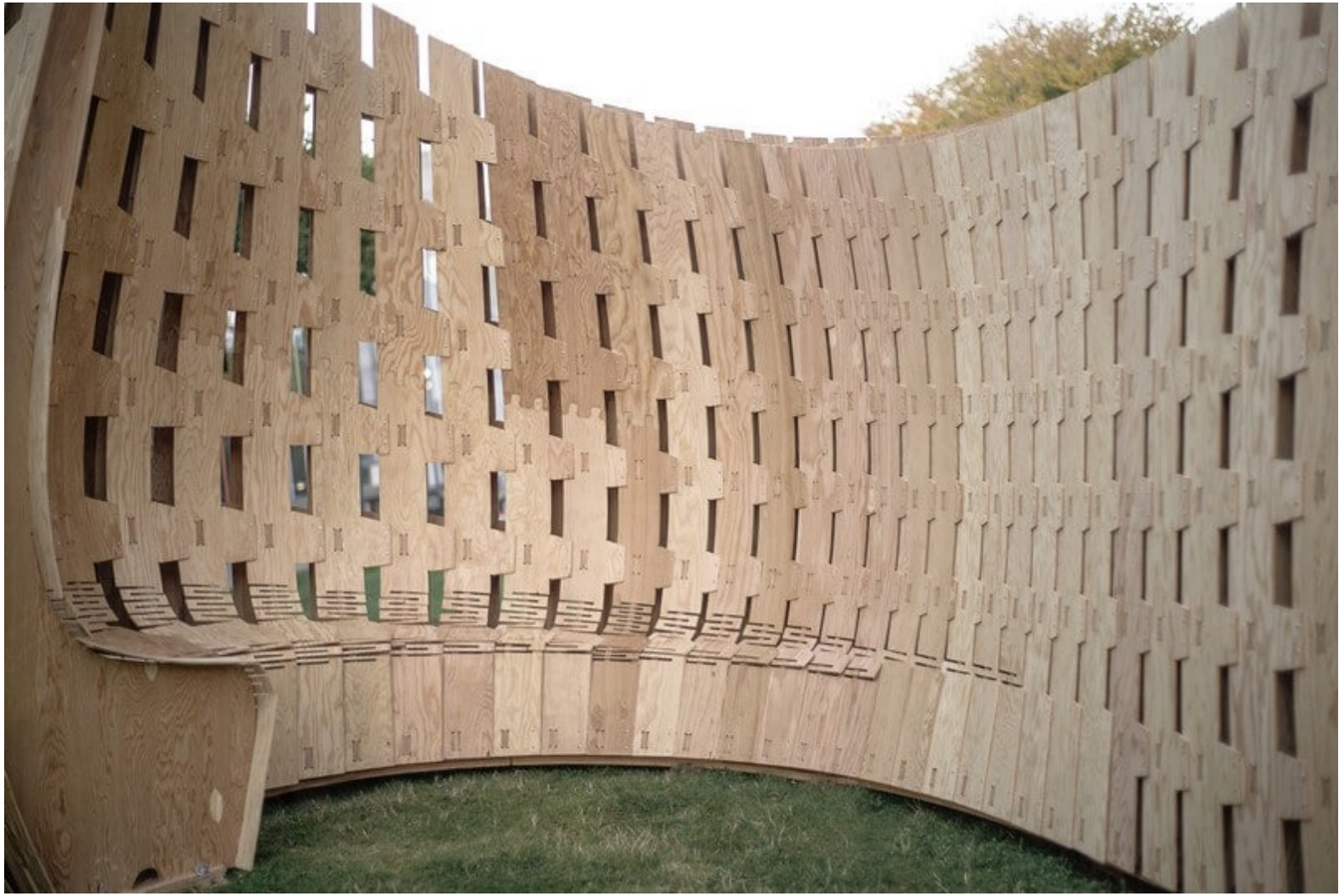
Formative – Kerf Bending

Wander Wood
Pavilion
Annalisa Meyboom



Formative – Kerf Bending

Wander Wood
Pavilion
Annalisa Meyboom



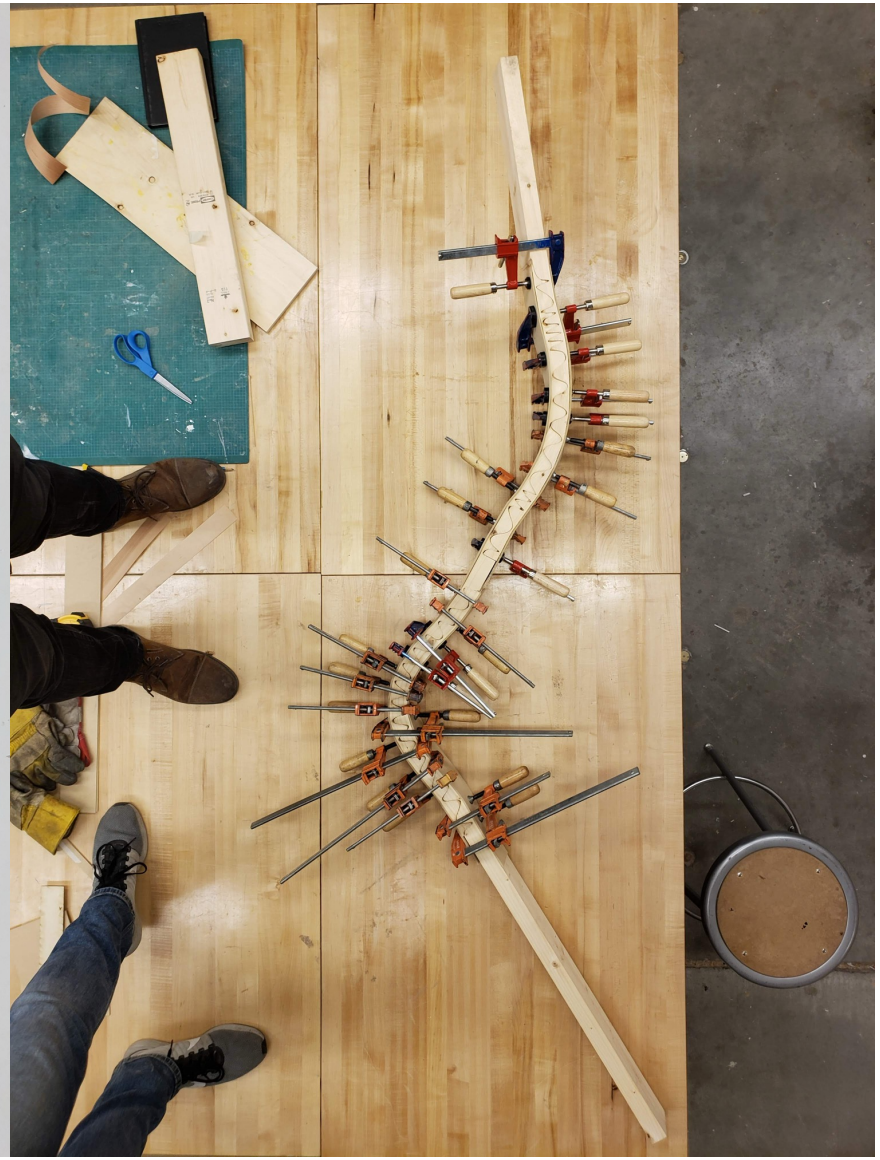
Formative – Kerf Bending



Wander Wood
Pavilion
Annalisa Meyboom

Formative – Kerf Bending

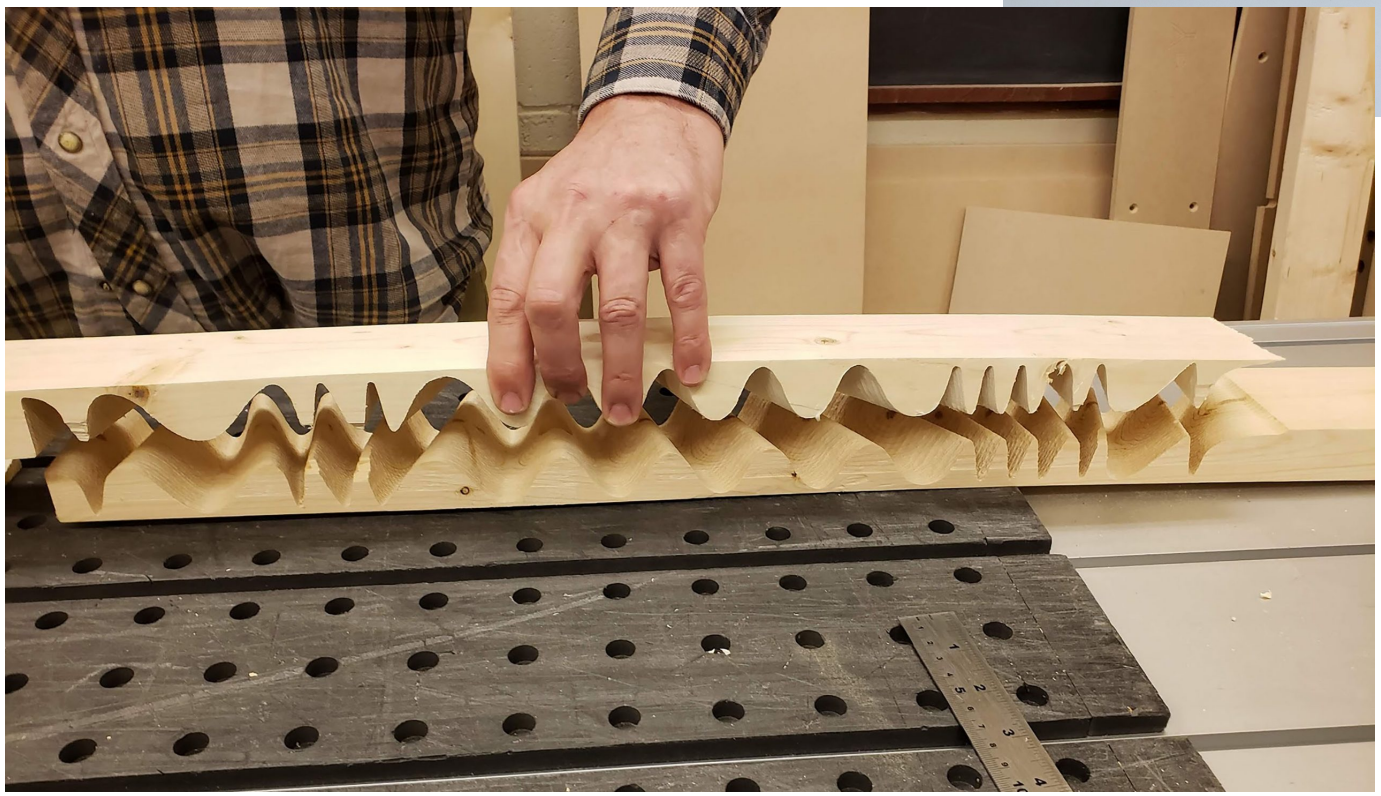




Zippered Wood
HiLo Lab

Formative – Kerf Bending



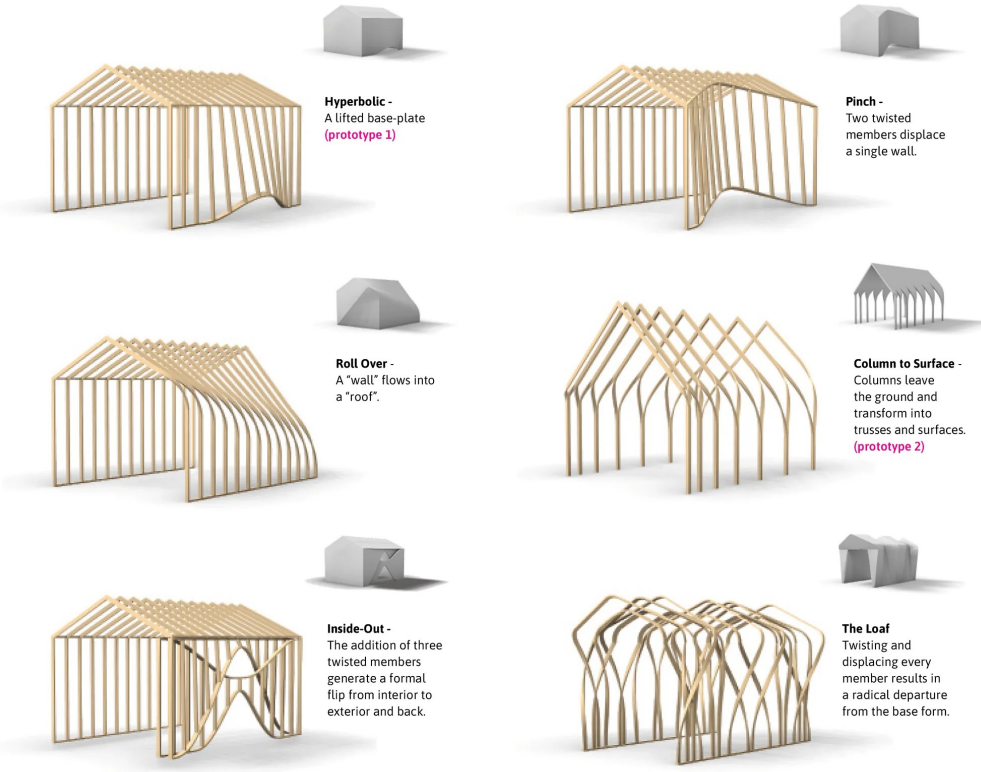


Zippered Wood
HiLo Lab

Formative – Kerf Bending

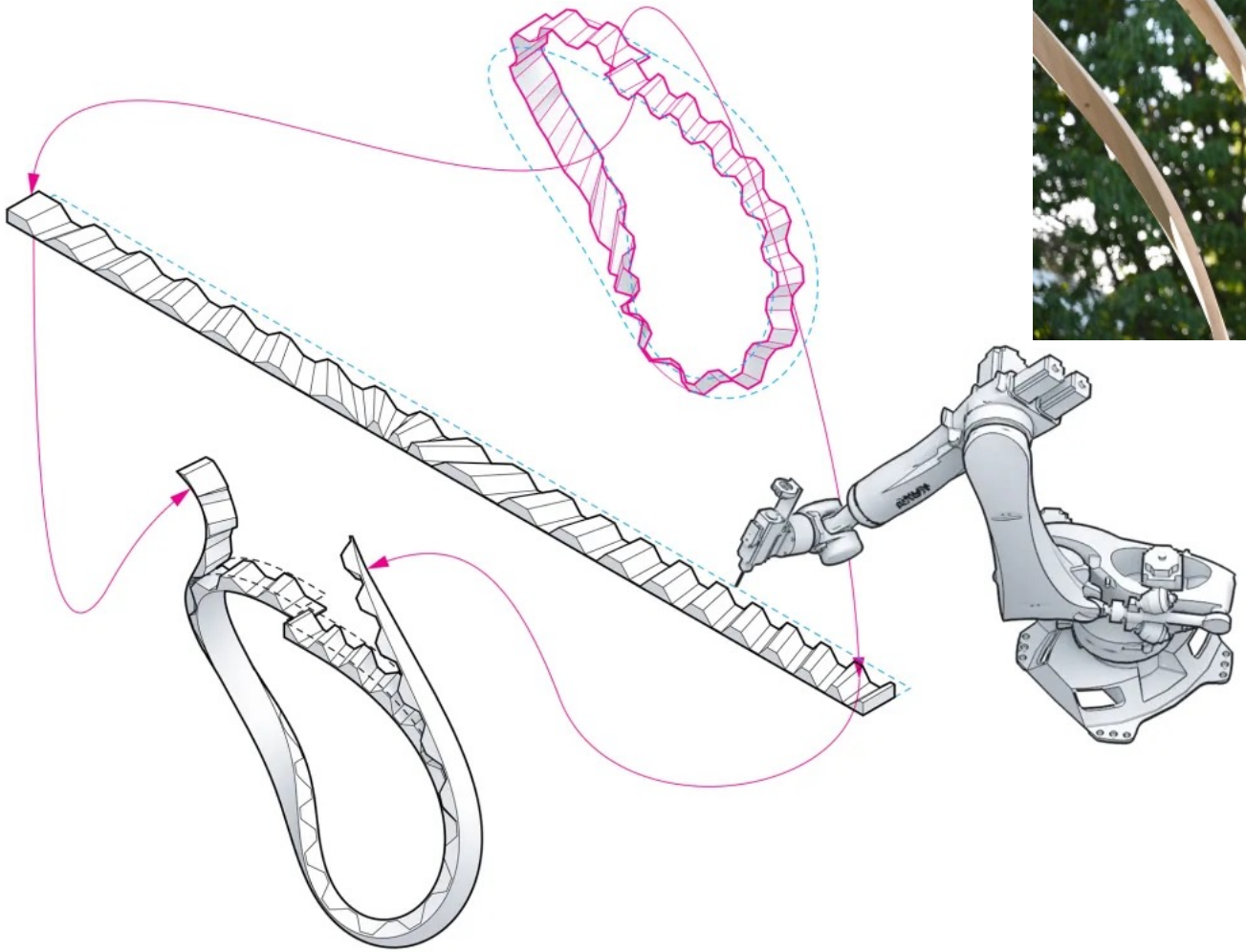
Zippered Wood
HiLo Lab





Formative – Kerf Bending





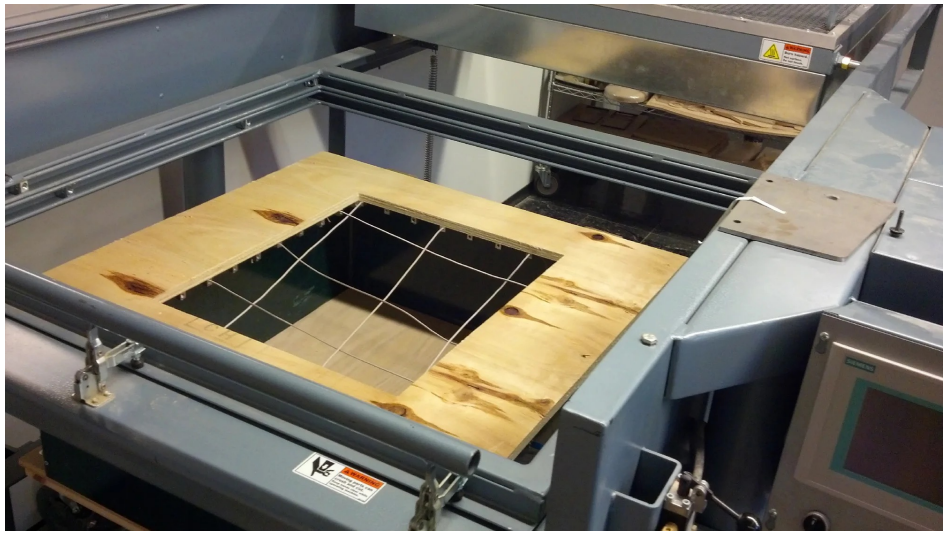
Zippered Wood
HiLo Lab

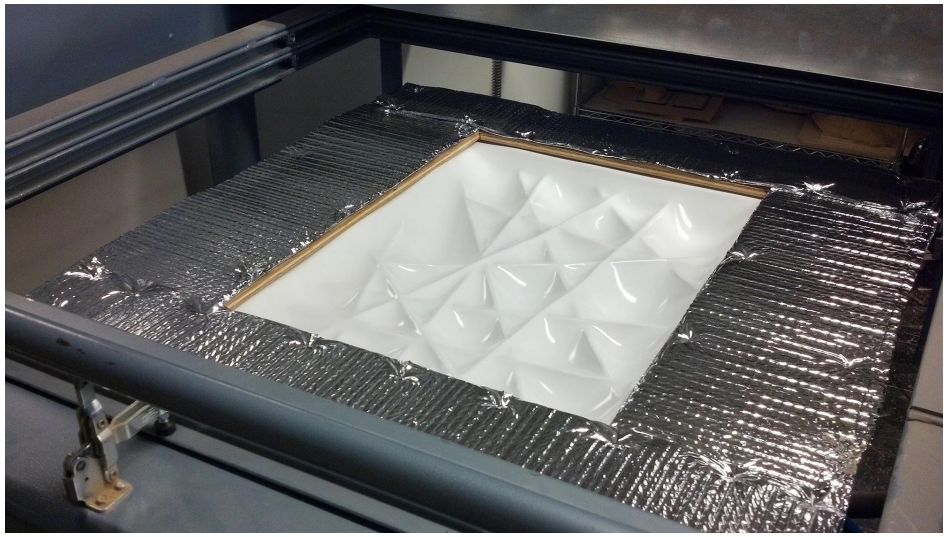
Formative - Vacuum



VarVac
HouMinn Practice
w/Philip Bussey

Formative - Vacuum





VarVac
HouMinn Practice
w/Philip Bussey

Formative - Vacuum





VarVac
HouMinn Practice
w/Philip Bussey

Formative - Vacuum

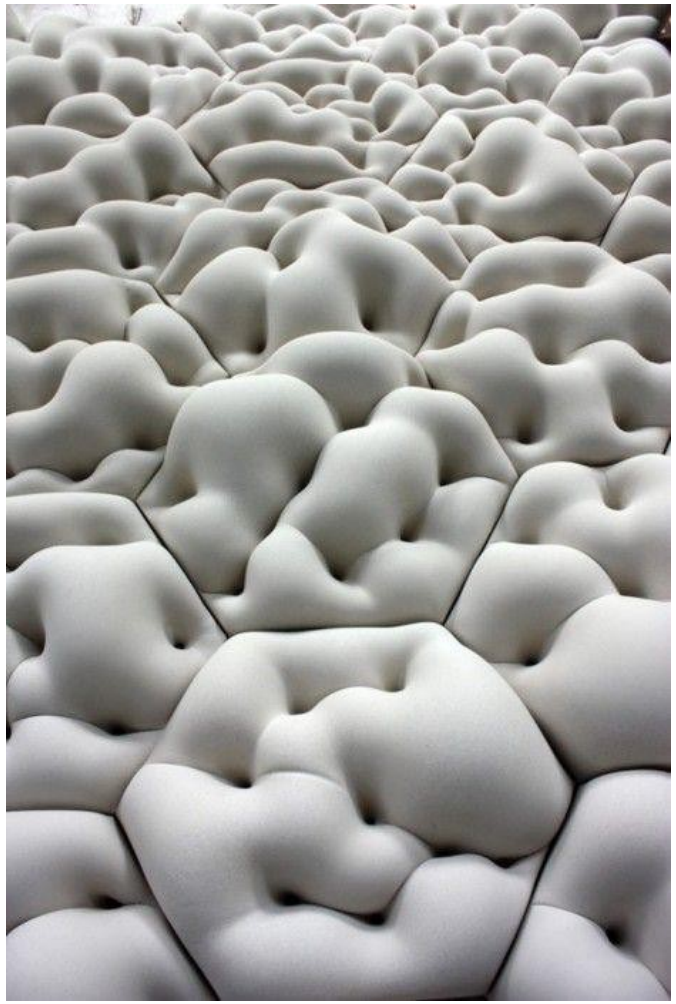




VarVac
HouMinn Practice
w/Philip Bussey

Formative - Casting

Paster





P_Wall
Andrew Kudless

Formative - Casting

Plaster

P_Wall
Andrew Kudless



Formative - Casting

Mycelium

Moma PS1
The Living



Formative - Casting

Mycelium

Moma PS1
The Living



Formative - Casting

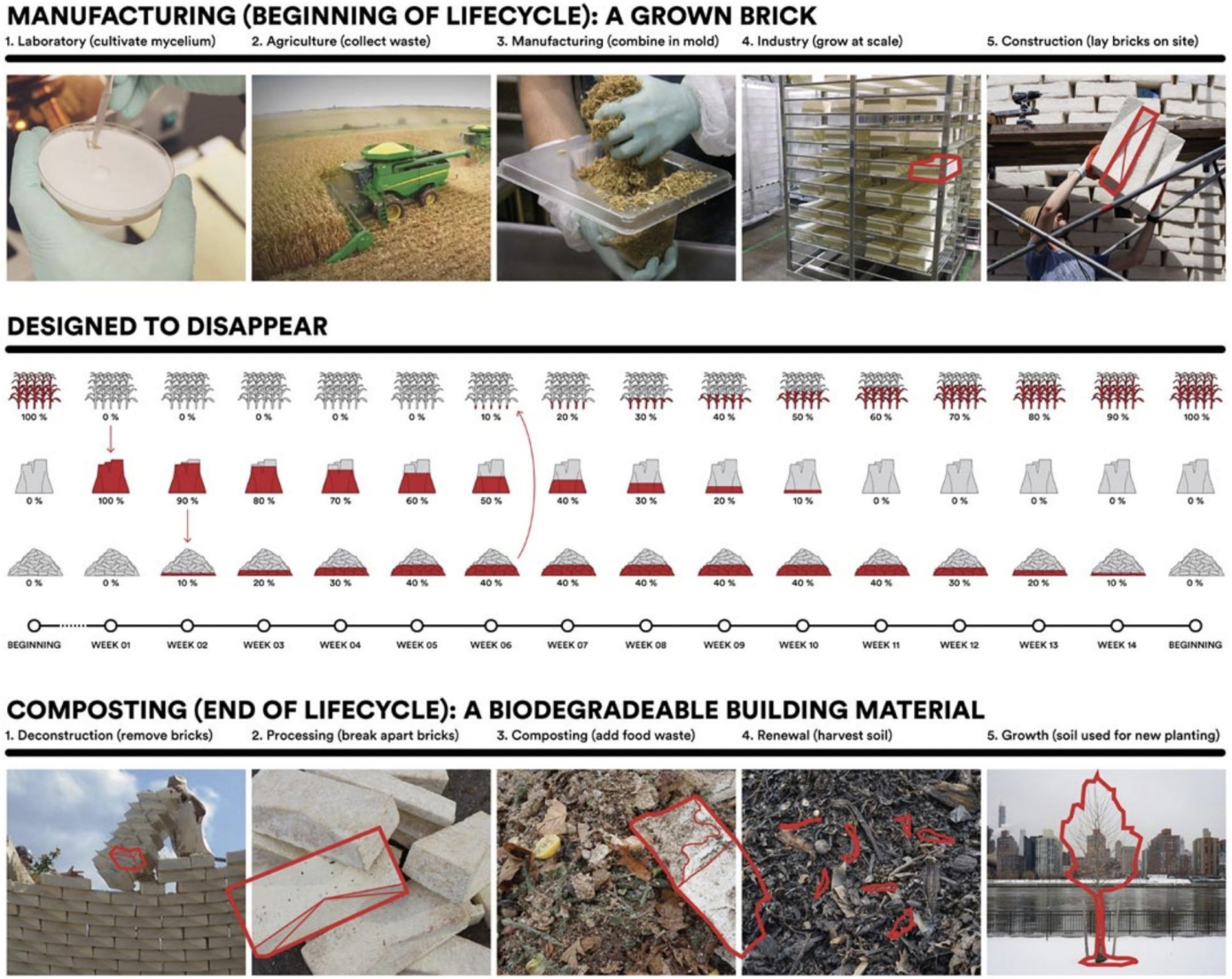




Moma PS1
The Living

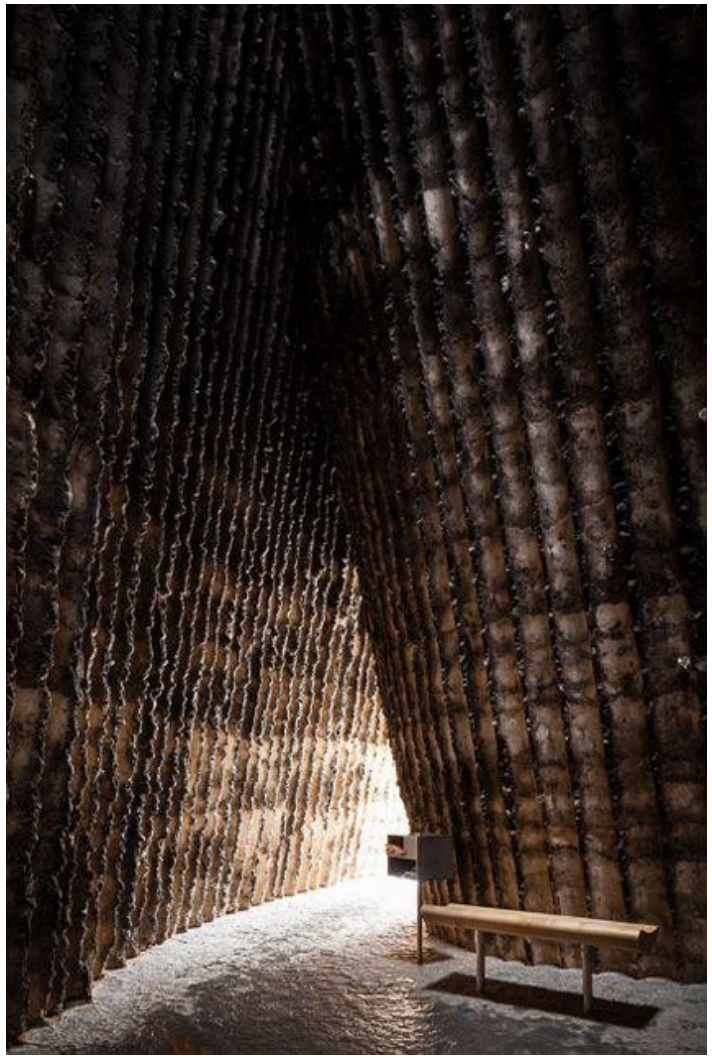
Formative - Casting

Moma PS1
The Living



Formative - Casting

Bruder Klaus Chapel
Peter Zumthor





Formative - Casting



Bruder Klaus Chapel
Peter Zumthor

Formative - Casting

Bruder Klaus Chapel
Peter Zumthor



Formative - Casting



Structures of Landscape for Tippet Rise Art Center, Montana. 2015

Ensamble Studio

Formative - Casting



Structures of Landscape for Tippet Rise Art Center, Montana. 2015

Ensamble Studio

Formative - Casting



Structures of Landscape for Tippet Rise Art Center, Montana. 2015

Ensamble Studio

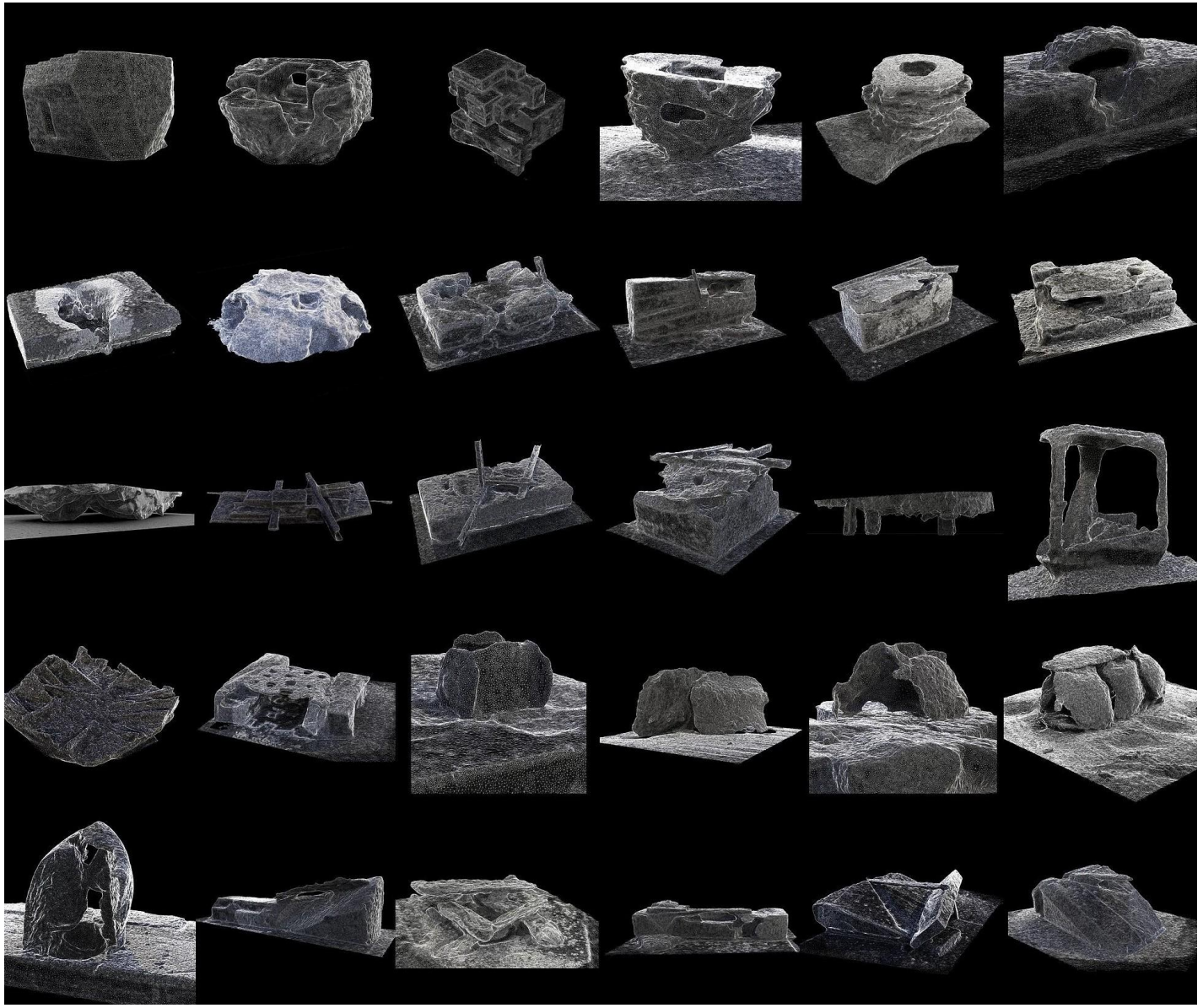
Formative - Casting



Structures of Landscape for Tippet Rise Art Center, Montana. 2015

Ensamble Studio

Formative - Casting



Structures of Landscape
for Tippet Rise Art
Center, Montana. 2015

Ensamble Studio

Formative - Casting



the Truffle House

Ensamble Studio

Formative - Casting





the Truffle House

Ensamble Studio



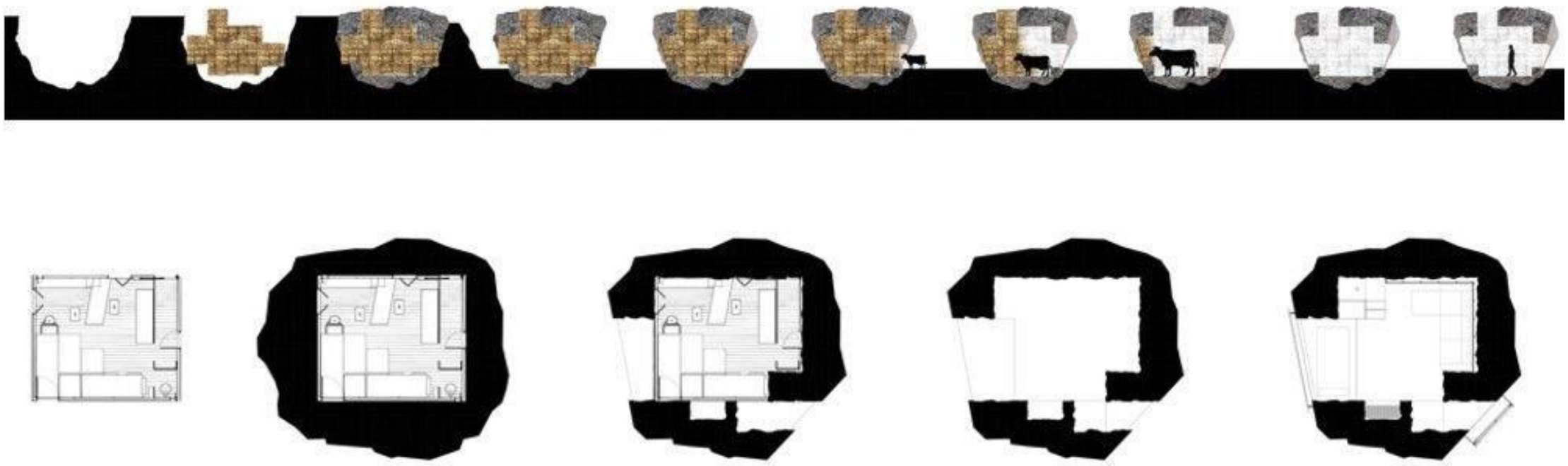
Formative - Casting



the Truffle House

Ensamble Studio

Formative - Casting



the Truffle House

Ensamble Studio