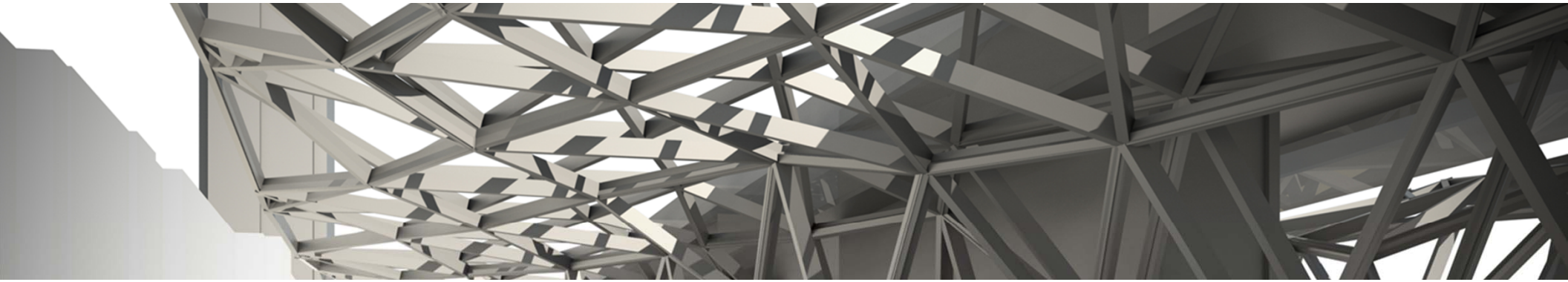
Building Students Skills with Design Computation + Fabrication

Danelle Briscoe

Assistant Professor – University of Texas at Austin



Introduction

Alex Wu | UT Austin Bachelor of Architecture Candidate 2017

Background / Experience

- Frank Gehry Partners, LLP.
  - Interactive Corporation, New York New York
- Marmol Radziner
- Academic:
  - Unitec New Zealand (2005-2009)
  - University of Texas at Austin (2009-present)
  - Visiting Faculty: AA London, Huazong Universiity, University of Auckland
- *Beyond BIM: Architecture Information Modelling*

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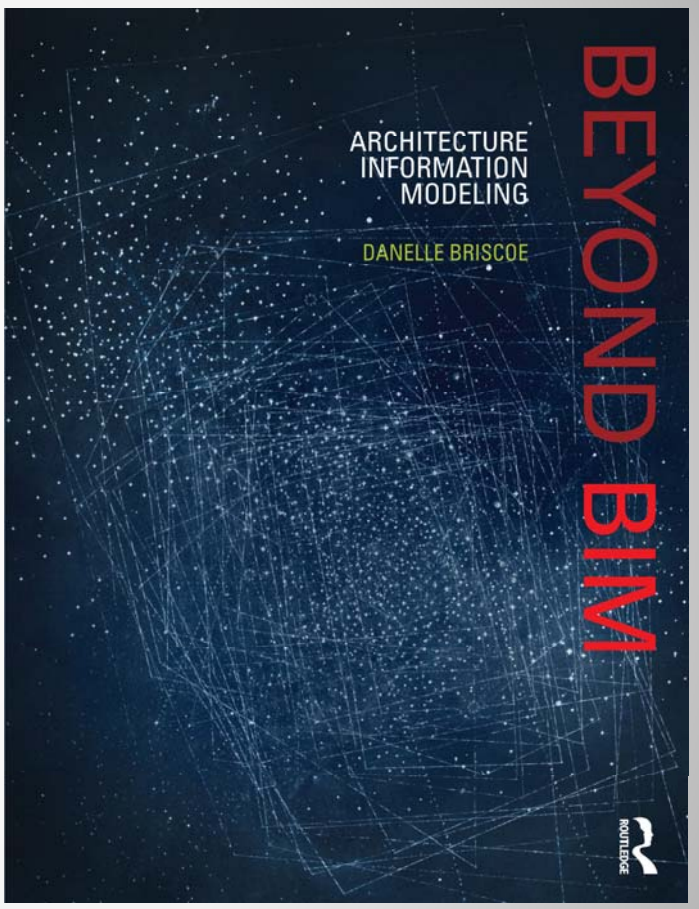


Objectives

- **Promote computational design skills** Learn various methods for introducing these new skills into courses and curriculum using Autodesk Revit® and Dynamo.
- **Help students with future careers** Hear how these advanced skills help meet the expectations of the current climate in practice, particularly the design sector.
- **Facilitate digital fabrication in building design** Learn how digital fabrication is facilitated through Revit and Dynamo visual programming.
- **Incorporate parametric modeling into the classroom** Learn how various courses assign parametric modeling in an architectural curriculum.

Academic Integration Case Studies

- **Core Curriculum:**
  - First Year Graduate Studio
  - Undergraduate First Year Design and Comprehensive Studio
  - Advanced Design (U.S. and Abroad)
  - Graduate Digital Drawing + Fabrication visual communication

- **Electives:**
  - *Beauty + the BIM*
  - *Material (IN)formation*

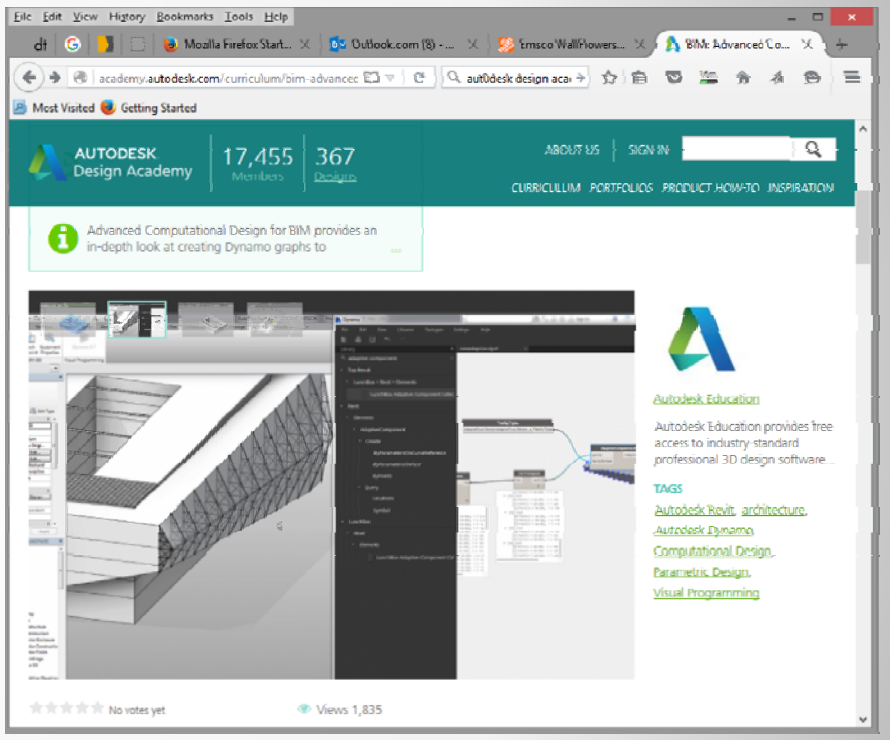
- **Independent Research:**
  - Information Erosion
  - Green Garage Pilot Project

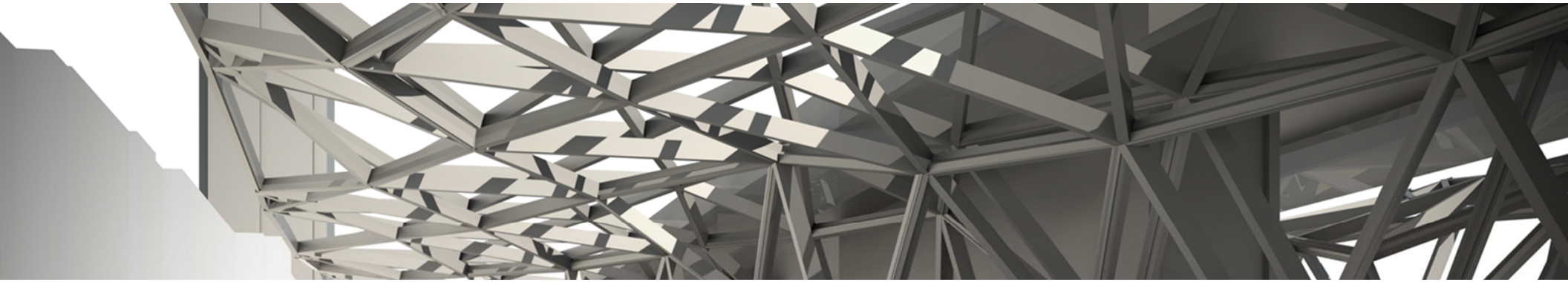
Digital Fabrication Tools Explored

- **Computer Numerically Controlled Milling (CNC)**
  - 3-Axis
  - 5-Axis Water-jet
- **Laser-cutting**
- **3D Printing**
  - Fused Deposition
  - Stereo-lithography

Benefits of the Design Academy

- Dynamo curriculum
- Hands-on projects
- Inspiration stories
- On-Air events
- Design Academy PPTs





Promote computational design skills

Alex Wu | UT Austin Bachelor of Architecture Candidate 2017

Design Studio Integration

- Allocate specific methodologies and manageable outcomes
- Introduce a short exercise at the beginning of the semester
- Initiate computational thinking with creativity

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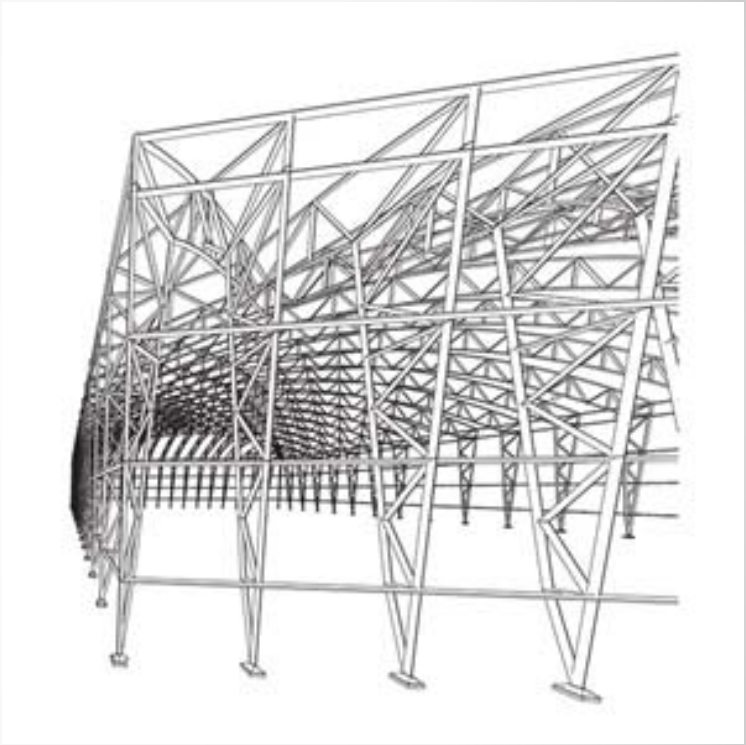


Graduate Vertical Design

- **University of Texas**
  Austin, Texas
  Fall 2009

- Wall sample exercise:
- Adaptive component to Conceptual Massing workflow in in Autodesk Design Academy with final 3d printed output

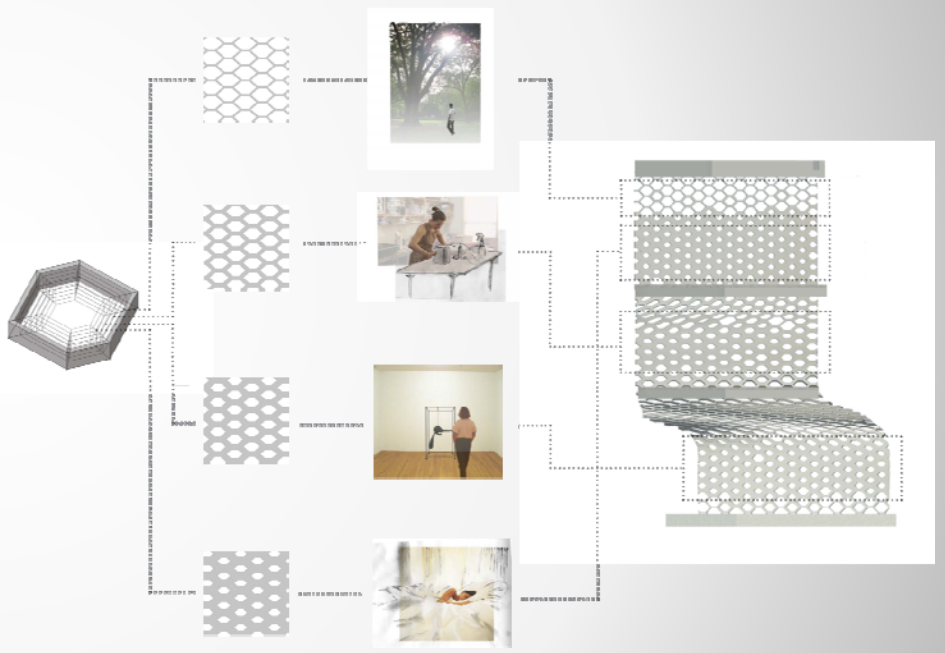


Image courtesy of Ken Dineen

Graduate Vertical Design

- **University of Texas**
  Austin, Texas
  Fall 2009

- Module exercise:
- Laser cut models directly from Revit plan view profiles, utilizing 123D Make for such extraction

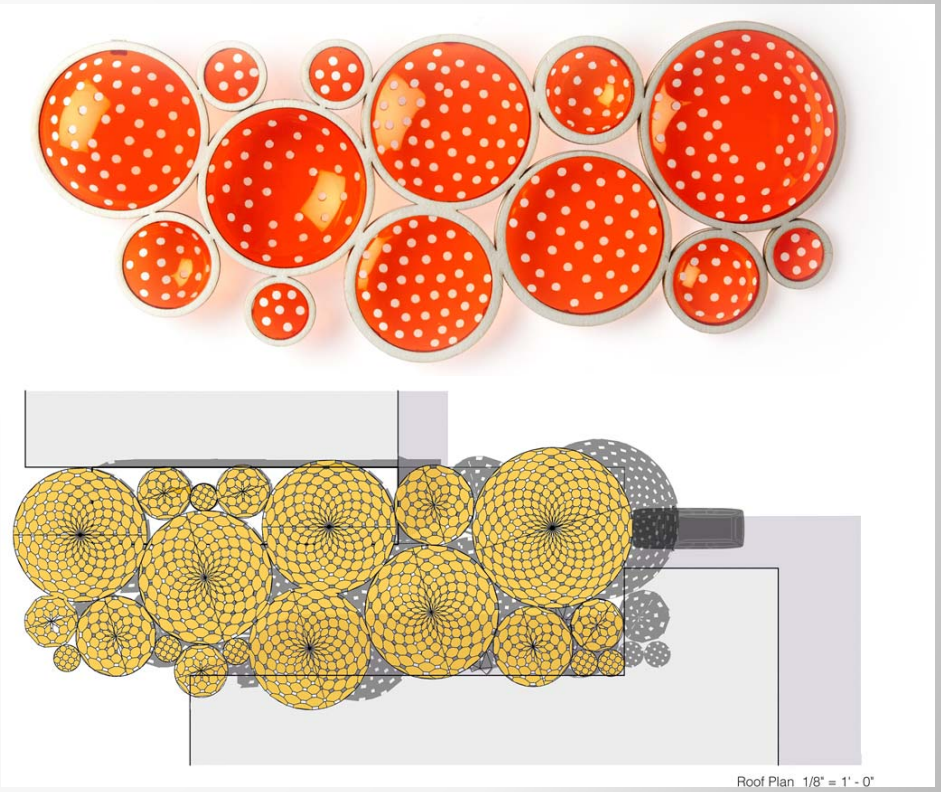
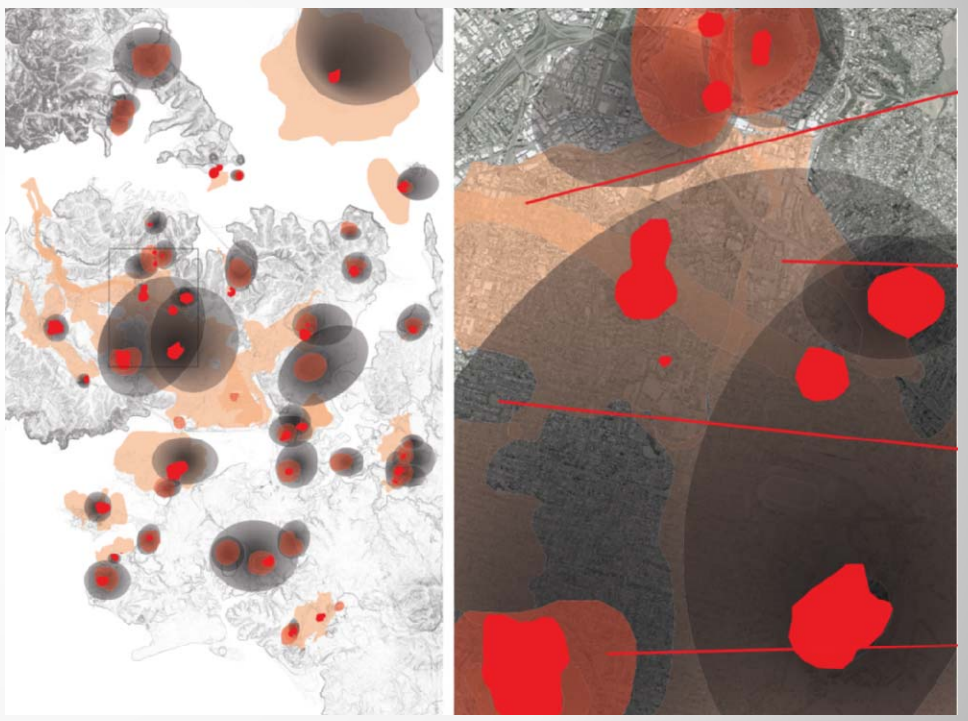


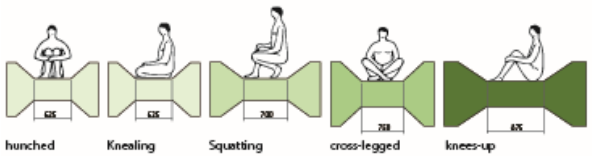
Image courtesy of Laura Grenard

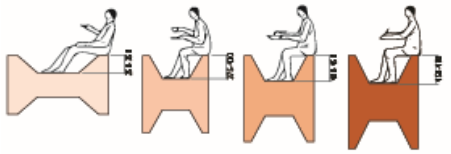
Advanced Design

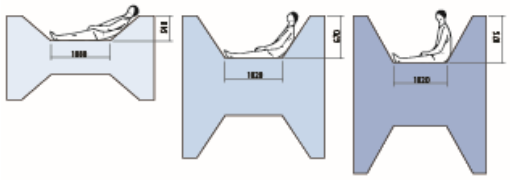
- **Unitec New Zealand, Auckland, NZ**
  Fall 2013

  - Test a bottom up design approach
  - ‘emergence’ of architecture and landscape information and patterns
  - Use scheduling as a creative design endeavor









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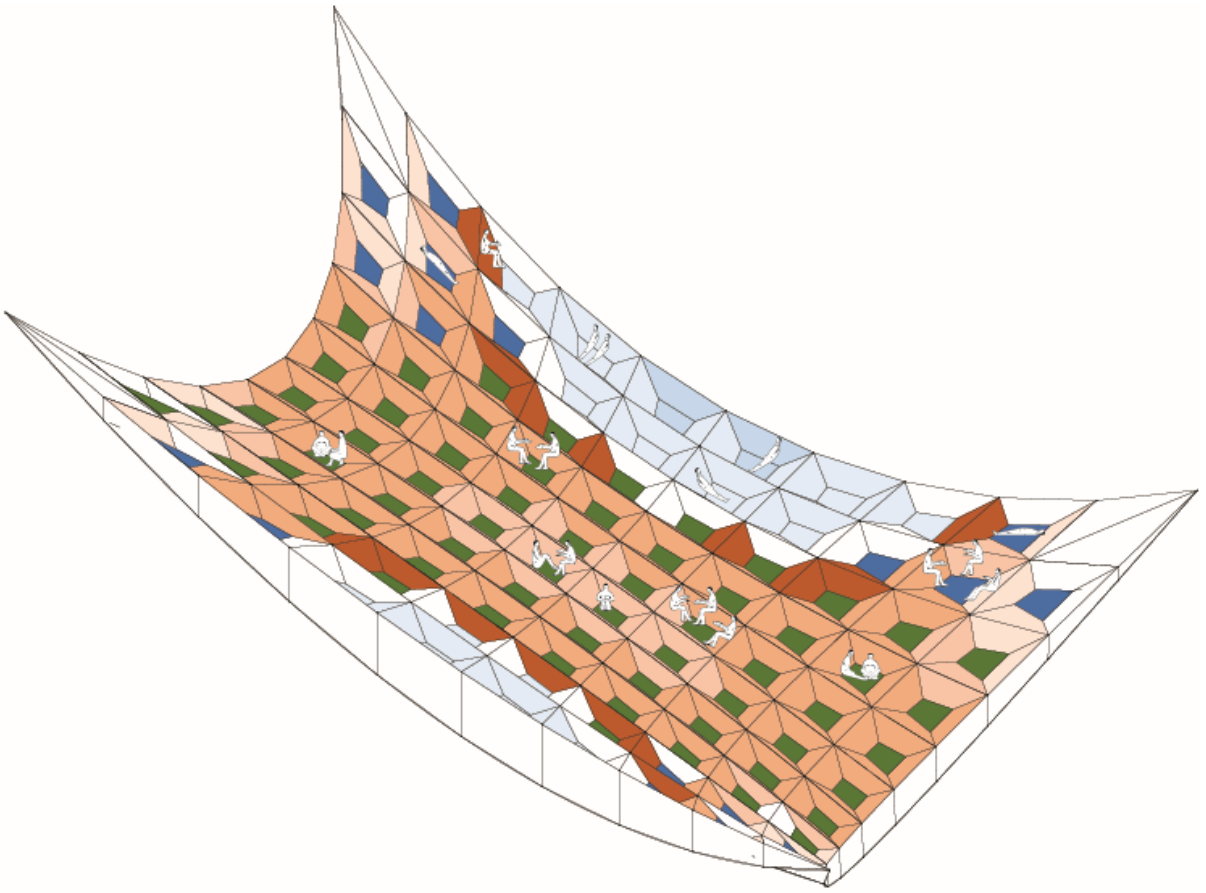

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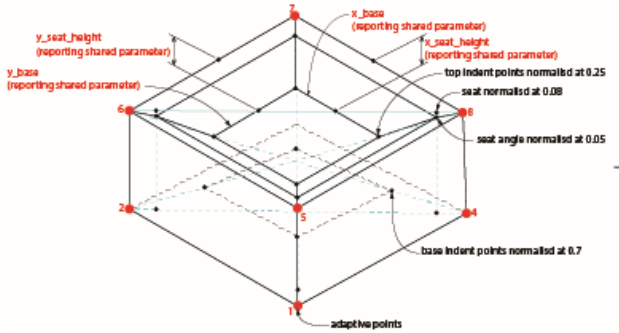
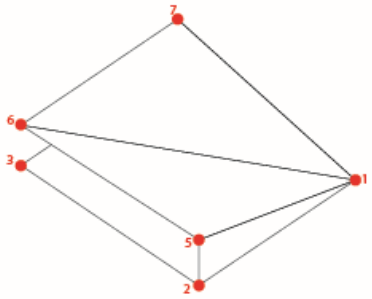
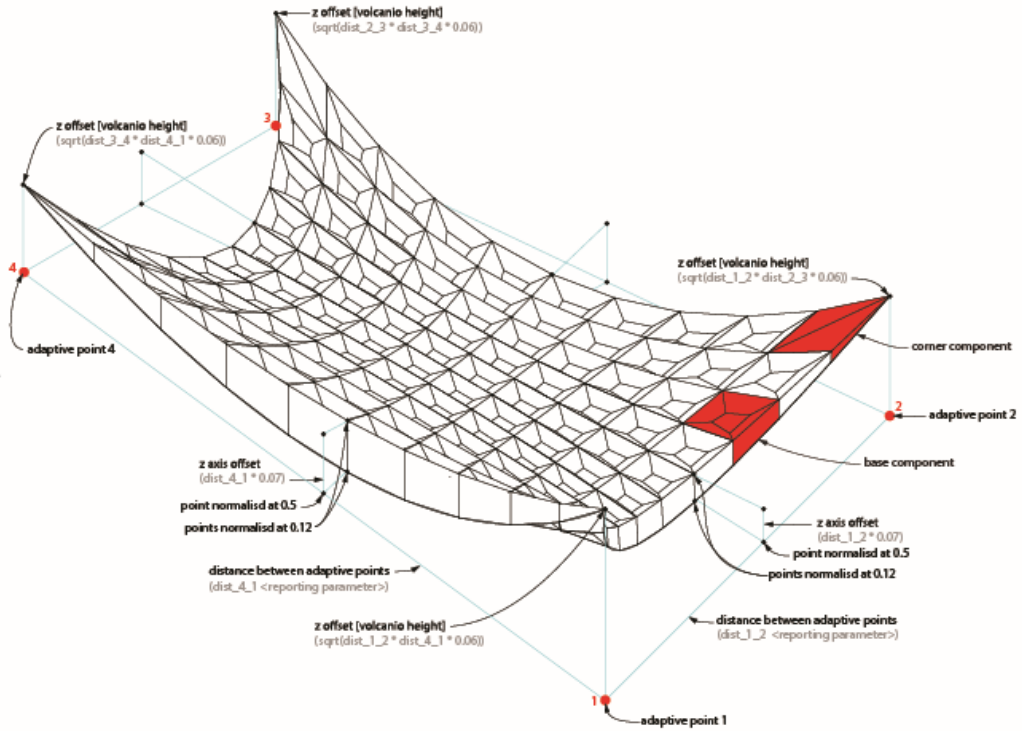


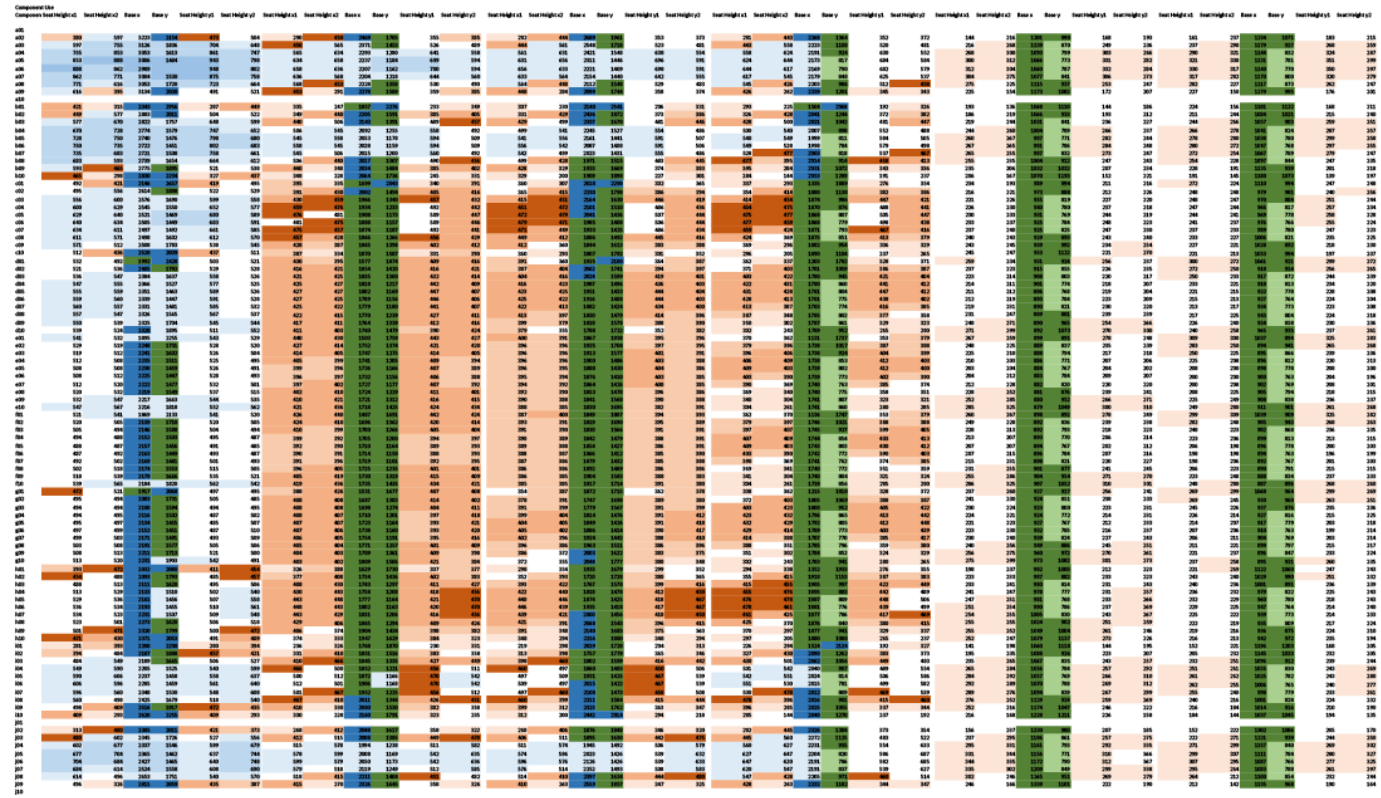
base component

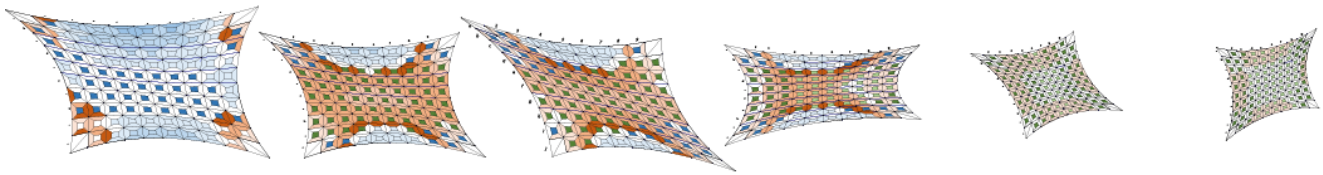


corner component



Field network





Advanced Design

- **University of Texas**
  Austin, Texas
  Fall 2010

- Parametric precedent research becomes a design driver for further design development.

Image courtesy of Laura Grenard

Advanced Design

- **University of Texas**
  Austin, Texas
  Fall 2010

- Understanding Type and Instance parameter to control color and pattern of a metal facade.

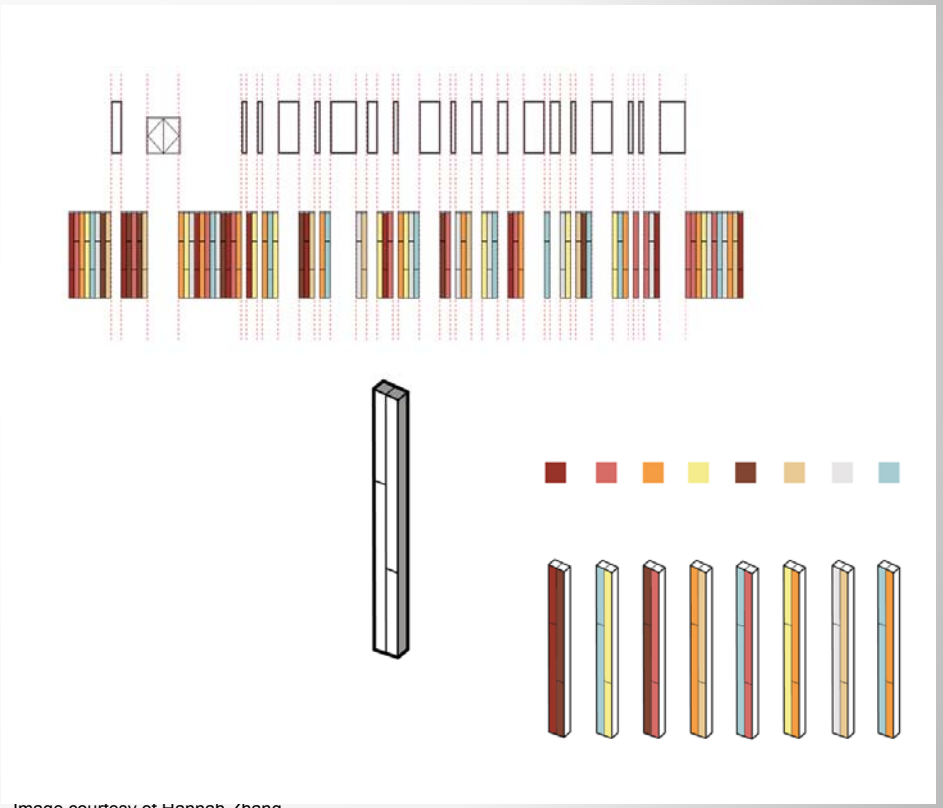
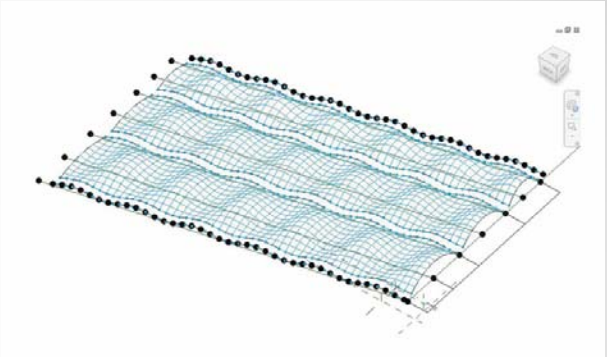


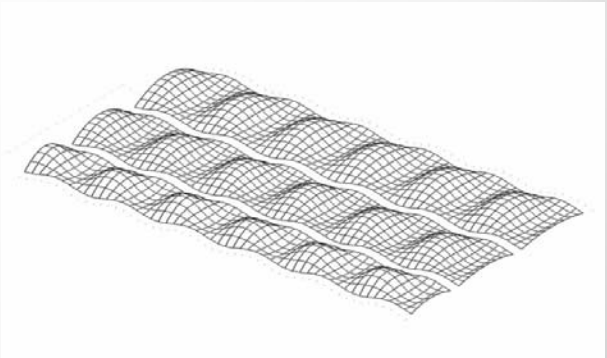
Image courtesy of Hannah Zhang

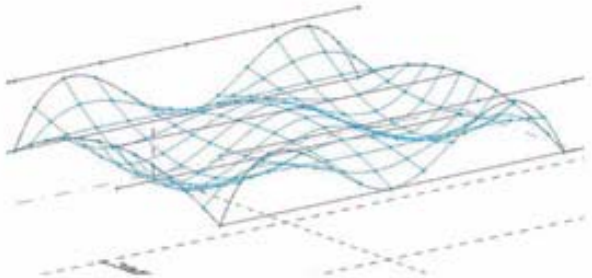
Undergraduate Third Year Design

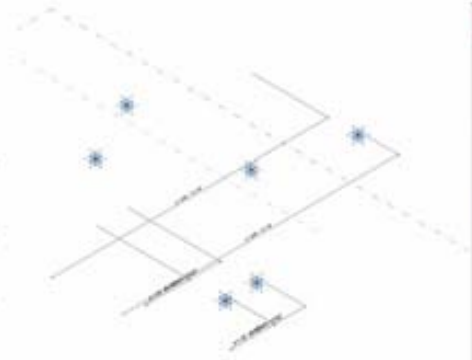
- **University of Texas, Austin, TX**
  Spring 2014

  - precedent research
  - Formulaic syntax within Revit adaptive point capabilities
  - Workshop setting within allotted studio hours, uses Design Academy inspiration stories









Family Types

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Dimensions			
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y offset	57' 10 75/256"	= sin((x / 1') * 1') * 80'	
Identity Data			

Parameter	Value	Formula
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displacement (default)	10' 0"	=
x (default)	20' 0"	= (point# - 1) * (step)
x2 (default)	33' 5 209/256"	=
y offset (default)	44' 3 125/256"	= amplitude * sin(2.75 * x / 1' - shift) * 1') + displacement
y2 offset (default)	0' 0 125/256"	= amplitude * sin(x2 / 1') * 1')
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Other		
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type3

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displacement (default)	20' 0"	=
x (default)	20' 0"	= (point# - 1) * (step)
x2 (default)	33' 5 209/256"	=
y offset (default)	44' 3 125/256"	= amplitude * sin(2.75 * x / 1' - shift) * 1') + displacement
y2 offset (default)	0' 0 125/256"	= amplitude * sin(x2 / 1') * 1')
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Other		
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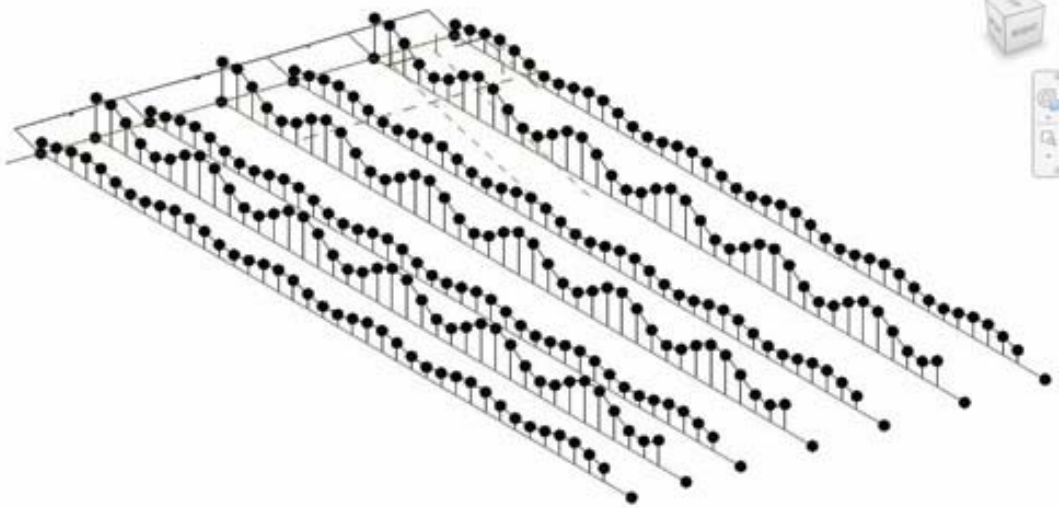
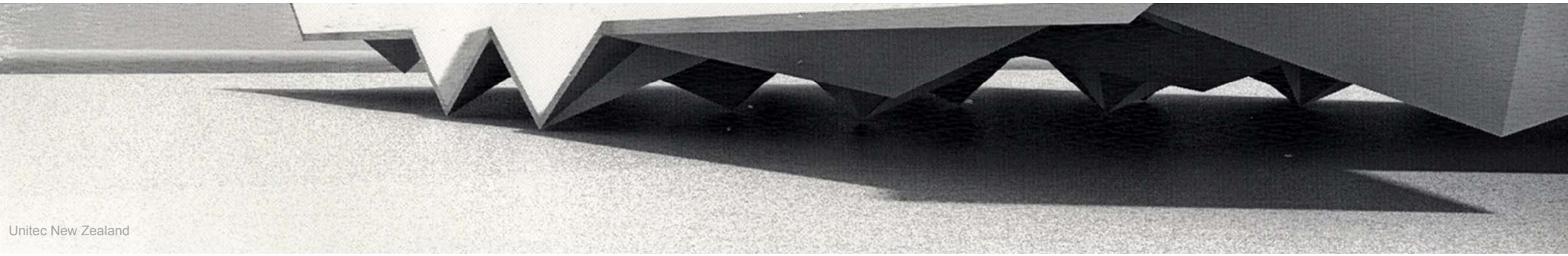


Help students with future careers



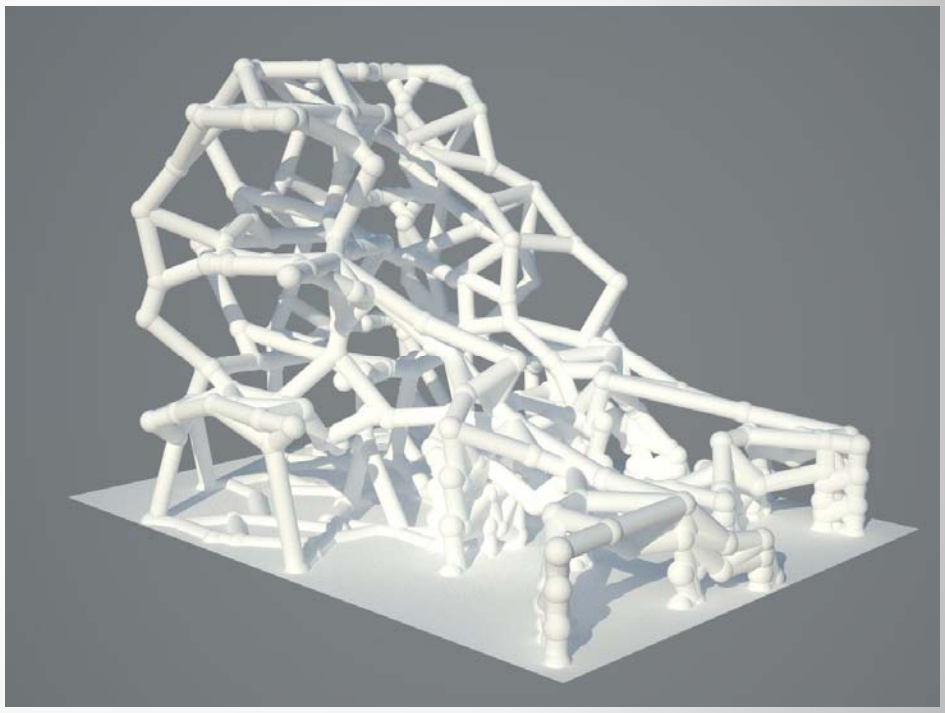
Unitec New Zealand

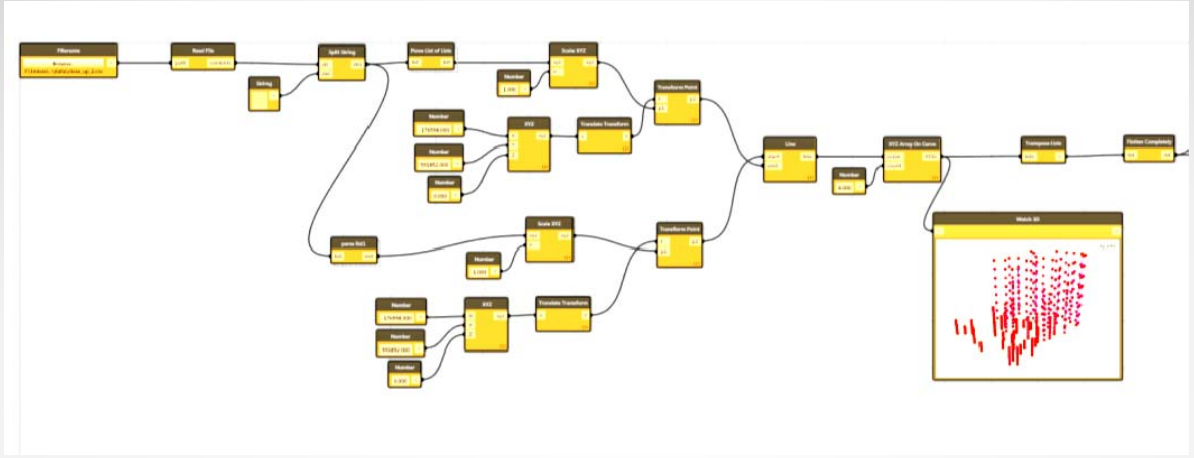
Advanced Design

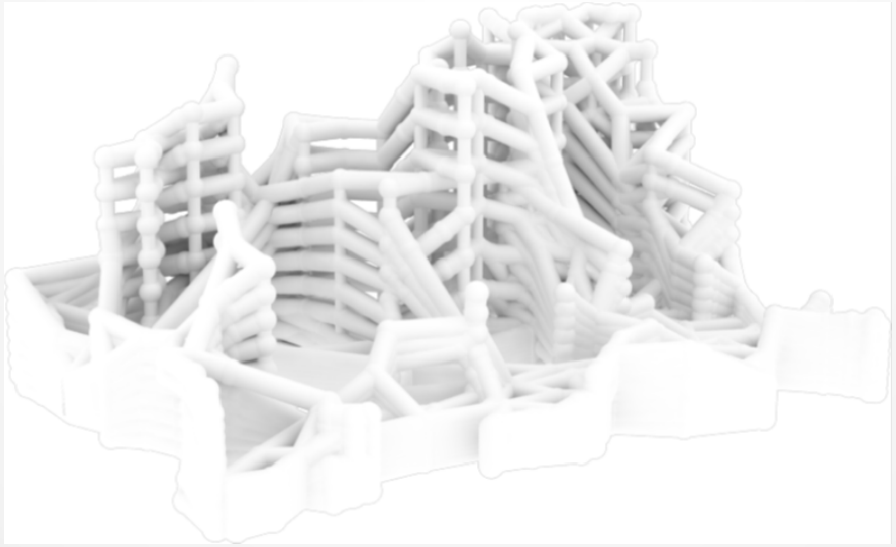
- **Unitec New Zealand, Auckland, NZ**
  Fall 2013

- Further advance skills in BIM for later course work

- To stay competitive, companies need to attract talent.





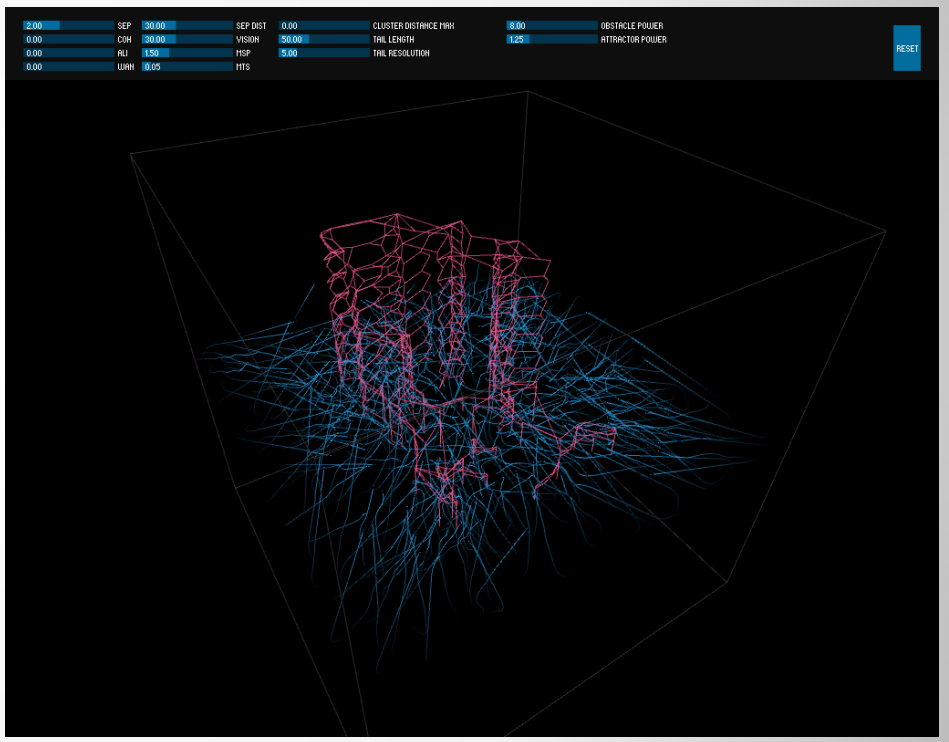


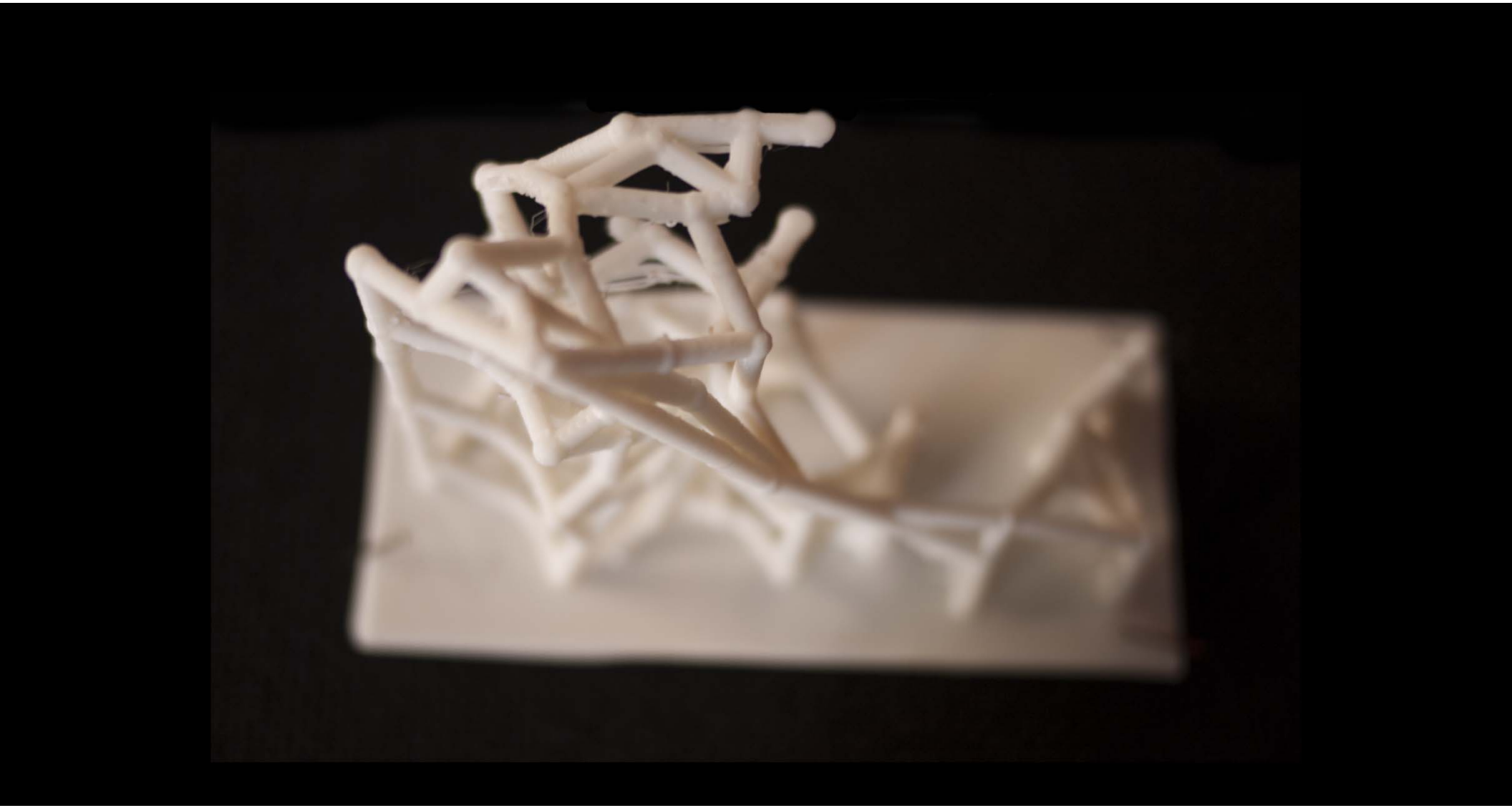
Advanced Design

- **Unitec New Zealand, Auckland, NZ**
  Fall 2013

  - *Processing* combined with Revit *Dynamo* visual programming

  - 3D printing exploration





Advanced Design

- **Huazong University of Science and Technology**
  Fall 2015

  - Rendering models for quick competition work
- **BIM: Intermediate Modeling**
  by Autodesk Education

Image courtesy of Hannah Zhang

Advanced Design

- **Huazong University of Science and Technology**
  Fall 2015

  - Displaced views covey constructability for competition brief

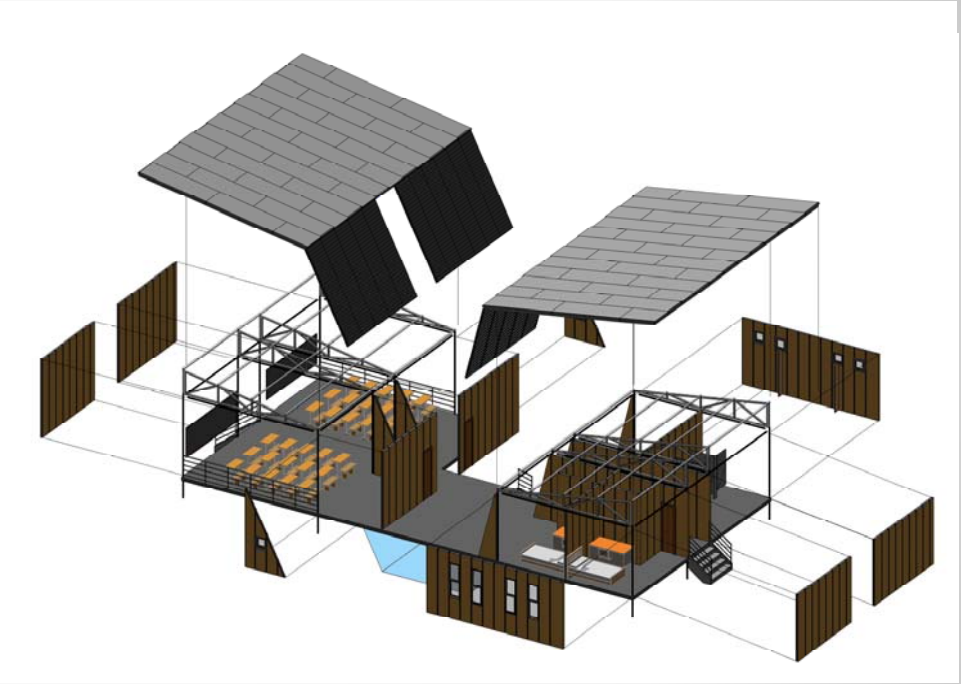


Image courtesy of Dong Liang

Advanced Design

- **University of Texas**
  Austin, Texas
  Fall 2010

  - 3d Printing models directly from Revit with STL exporter

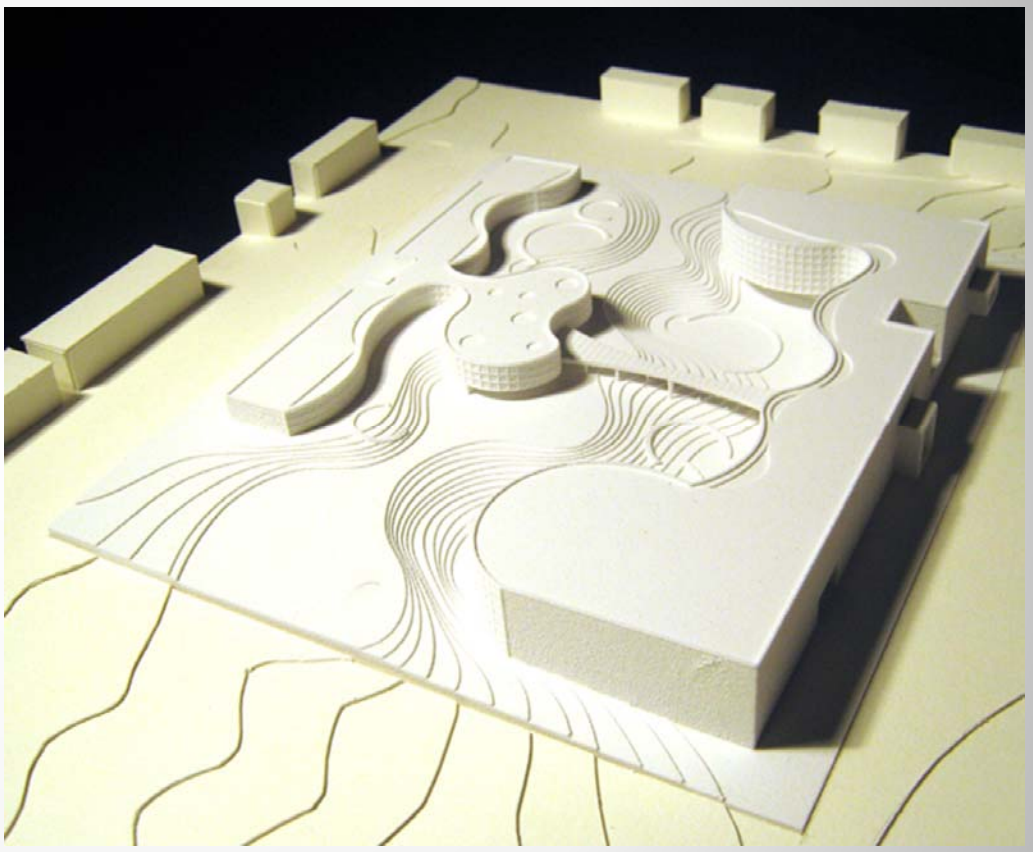


Image courtesy of Hannah Zhang

Green Wall Pilot Project

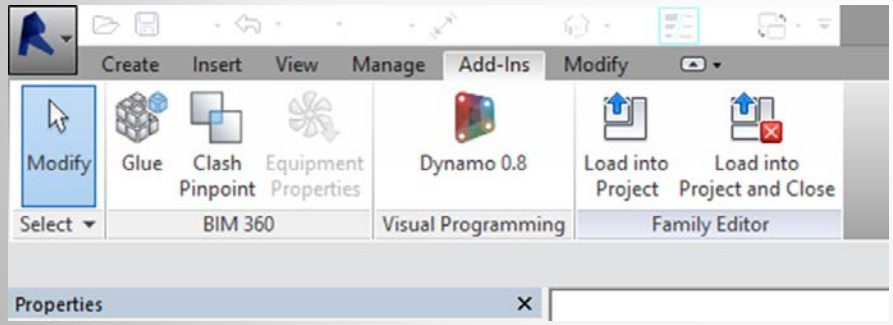
- ongoing joint interest between the University of Texas at Austin and the City of Austin
- Explore viability of a living wall system on an existing university owned parking garage
- West facing in hot and dry climate of Austin, Texas

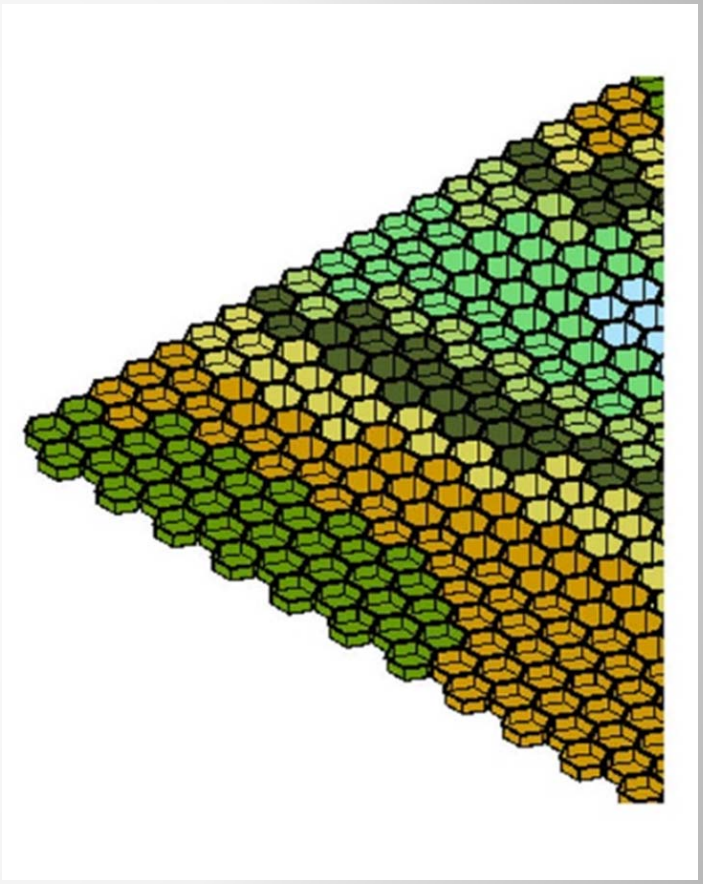
Image courtesy Danelle Briscoe

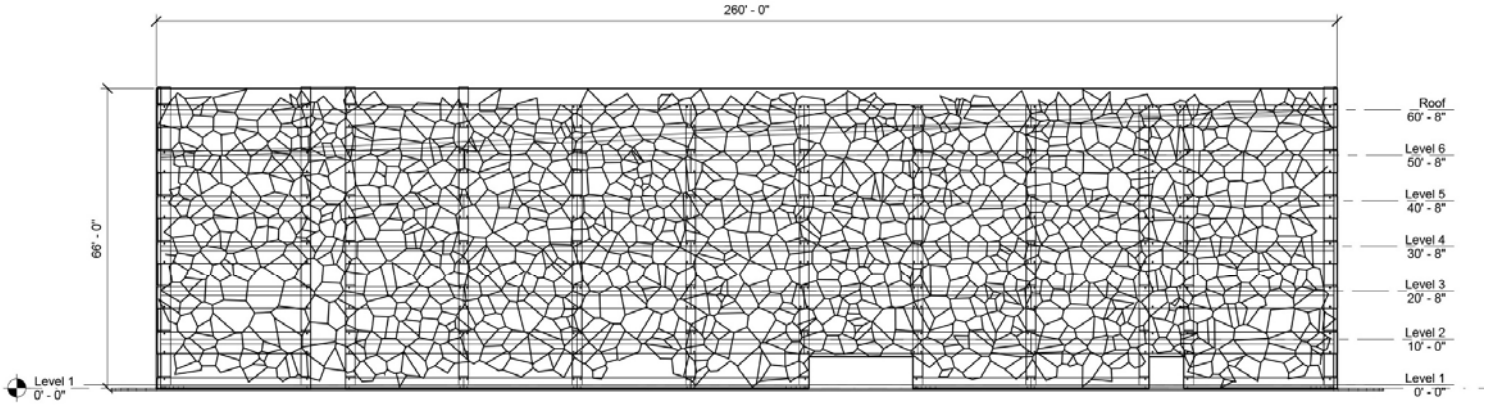

16th

Green Wall Pilot Project

- Revit Workflow: Dynamo visual programming






260' - 0"
66' - 0"
Roof
60' - 8"
Level 6
50' - 8"
Level 5
40' - 8"
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Level 3
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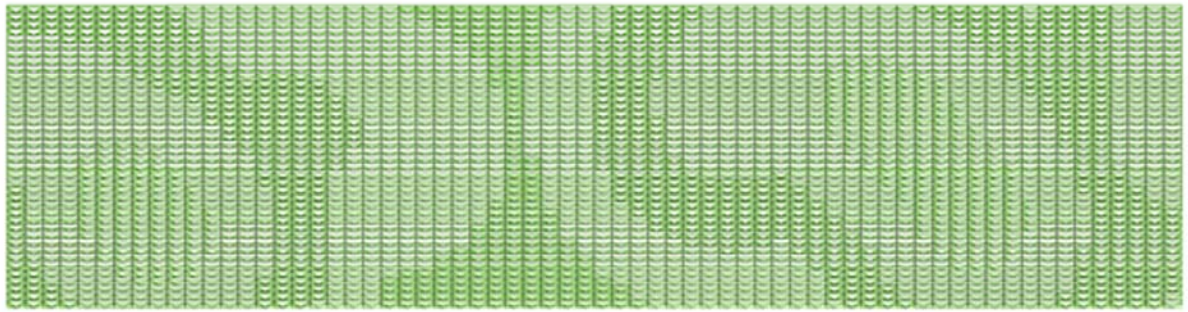
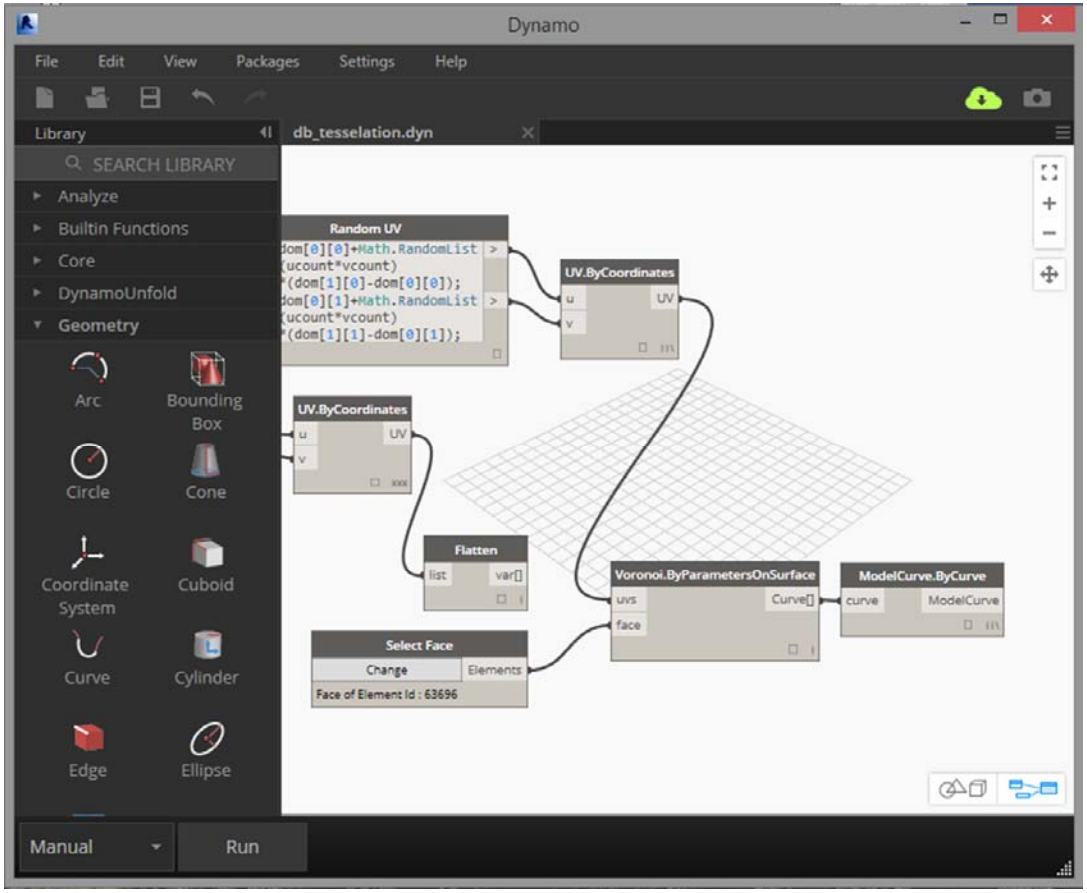
Level 1
0' - 0"




Dynamo
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View
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Analyze
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Bounding Box
Circle
Cone
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Cylinder
Edge
Ellipse
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var[]
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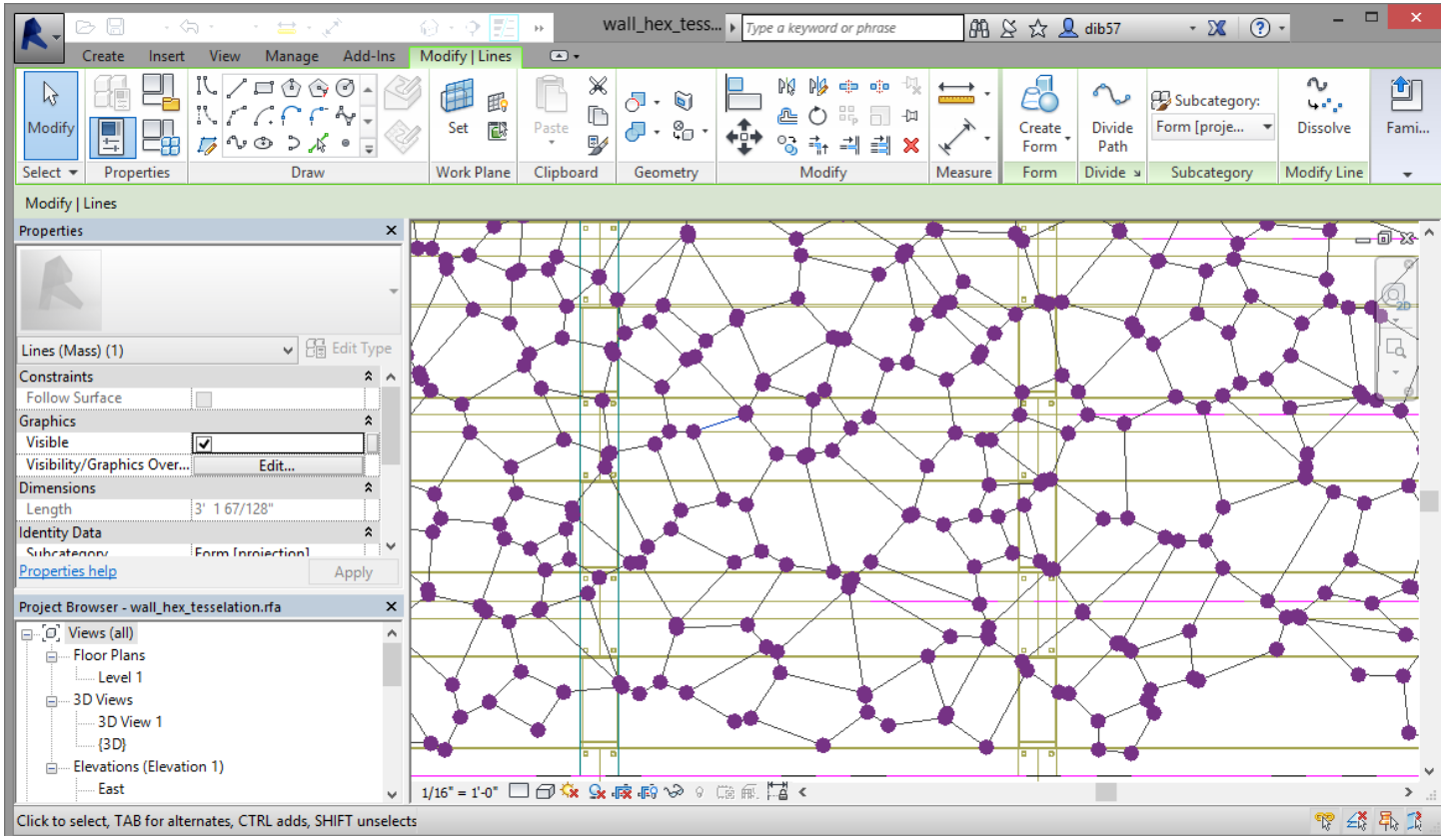
wall_hex_tess...
Type a keyword or phrase
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Create
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Add-Ins
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Constraints
Follow Surface
Graphics
Visible
Visibility/Graphics Over...
Edit...
Dimensions
Length
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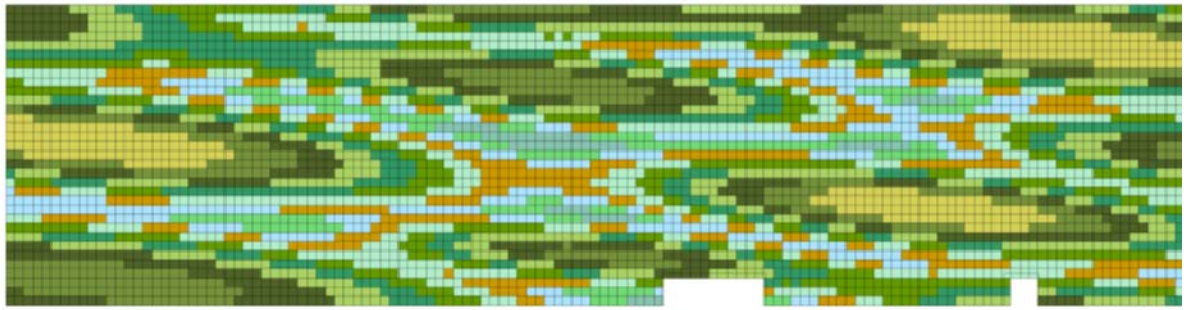
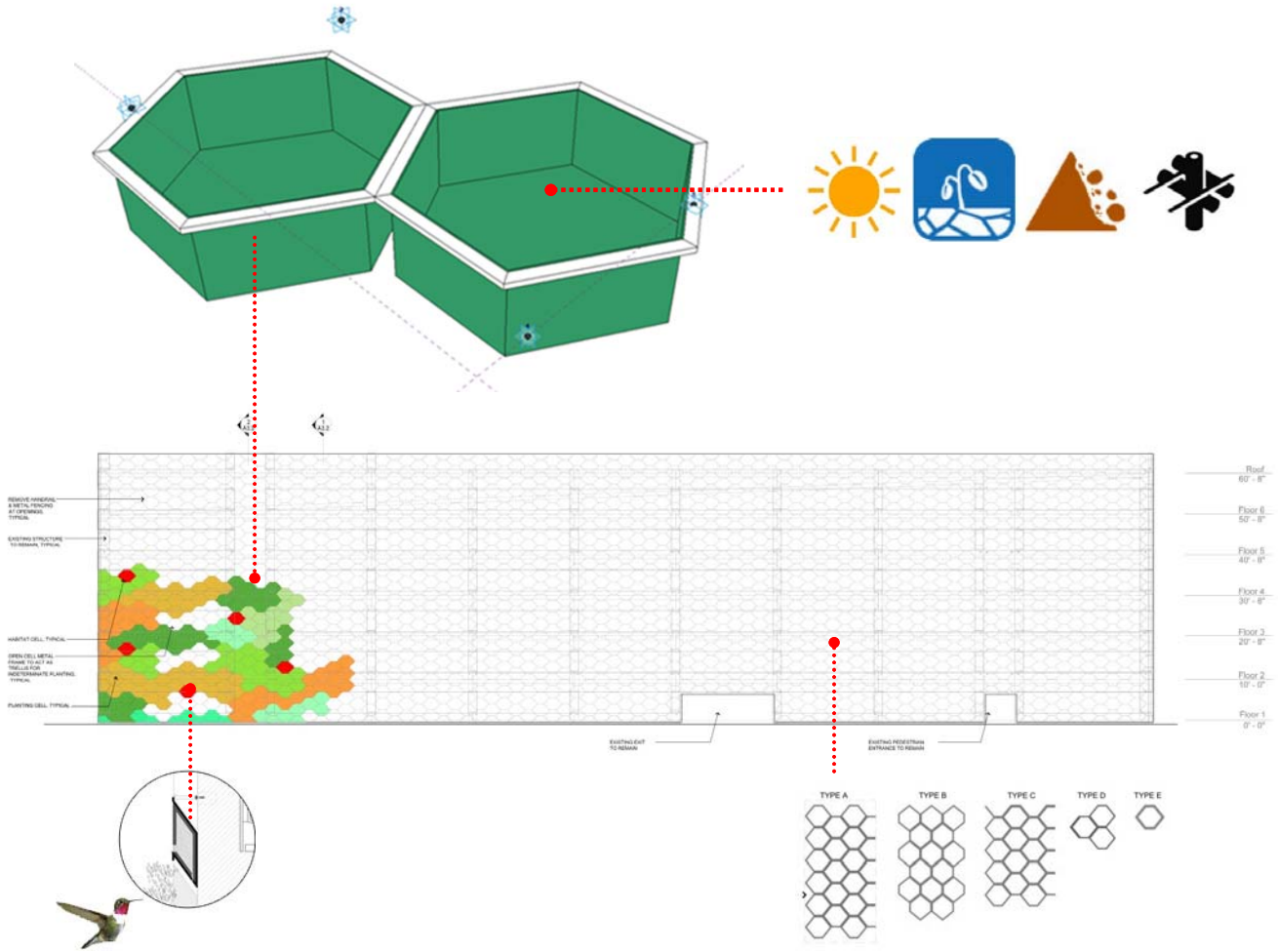
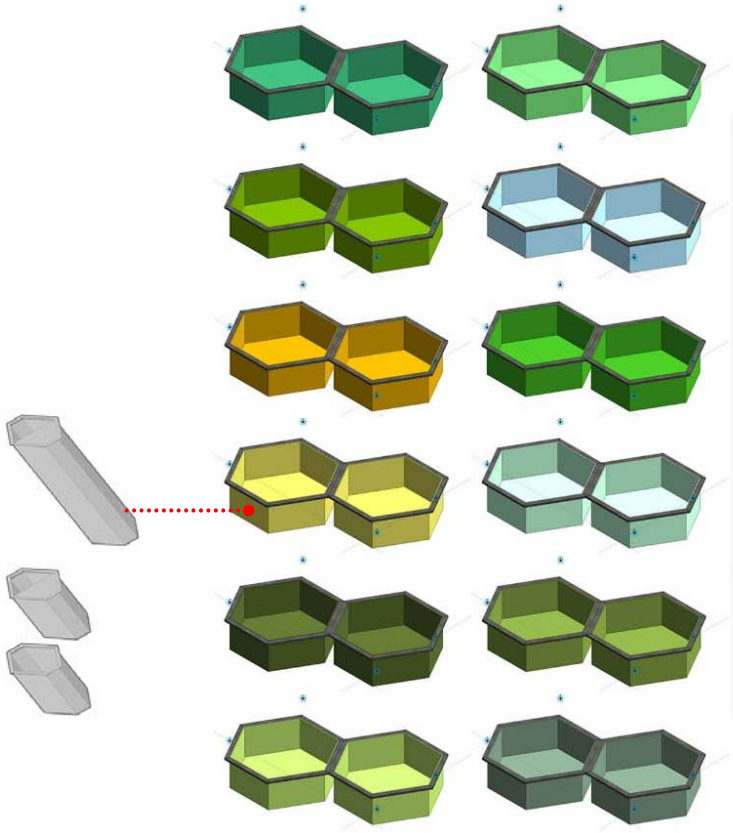
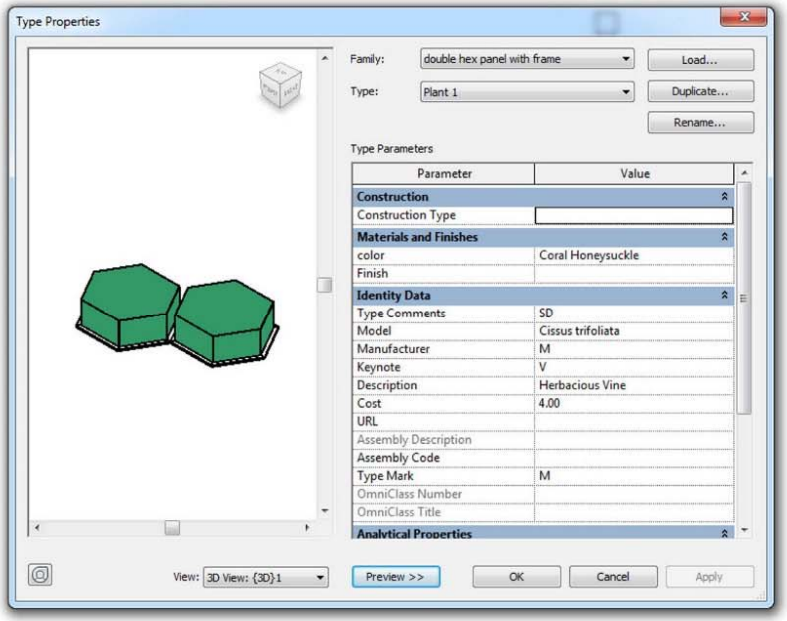
Identity Data
Properties help
Apply
Project Browser - wall_hex_tesselation.rfa
Views (all)
Floor Plans
Level 1
3D Views
3D View 1
{3D}
Elevations (Elevation 1)
East
1/16" = 1'-0"
Click to select, TAB for alternates, CTRL adds, SHIFT unselects




REMOVE HANDRAIL & METAL FENCING AT DRIVEWAY, TYPICAL
EXISTING STRUCTURE TO REMAIN, TYPICAL
HABITAT CELL, TYPICAL
OPEN CELL METAL FRAME TO ACT AS TRELLIS FOR INDETERMINATE PLANTING, TYPICAL
PLANTING CELL, TYPICAL
Roof 60' - 8"
Floor 6 50' - 8"
Floor 5 40' - 8"
Floor 4 30' - 8"
Floor 3 20' - 8"
Floor 2 10' - 0"
Floor 1 0' - 0"
EXISTING EXIT TO REMAIN
EXISTING PEDESTRIAN ENTRANCE TO REMAIN
TYPE A
TYPE B
TYPE C
TYPE D
TYPE E

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Family: double hex panel with frame
Load...
Type: Plant 1
Duplicate...
Rename...
Type Parameters
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Construction
Construction Type
Materials and Finishes
color
Coral Honeysuckle
Finish
Identity Data
Type Comments
SD
Model
Cissus trifoliata
Manufacturer
M
Keynote
V
Description
Herbacious Vine
Cost
4.00
URL
Assembly Description
Assembly Code
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M
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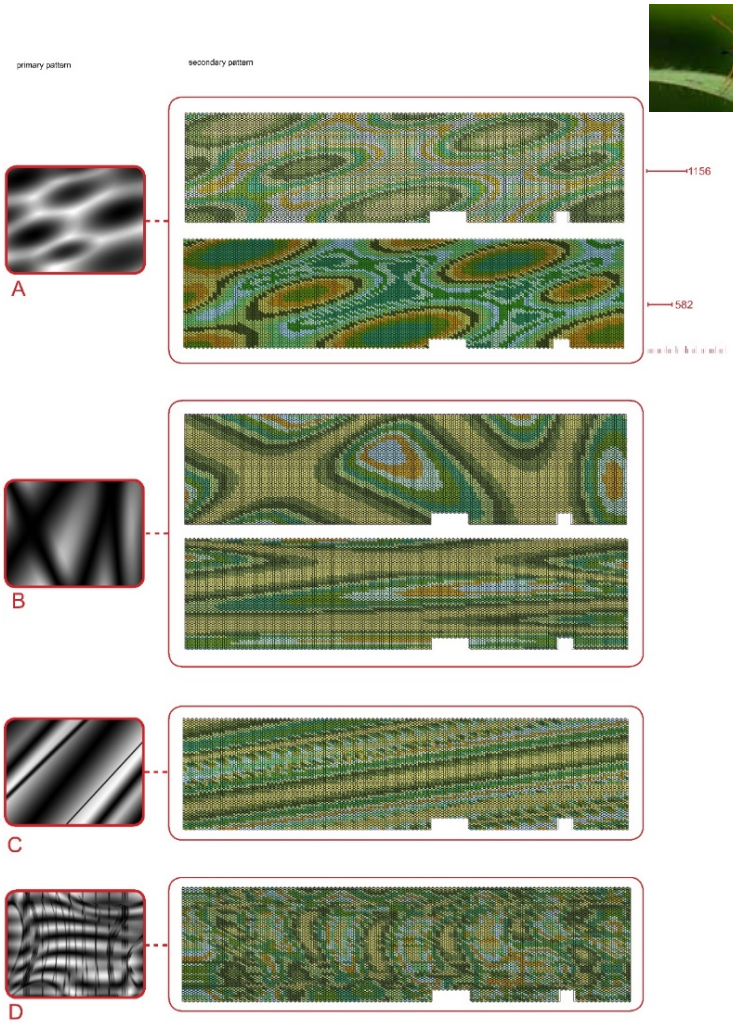
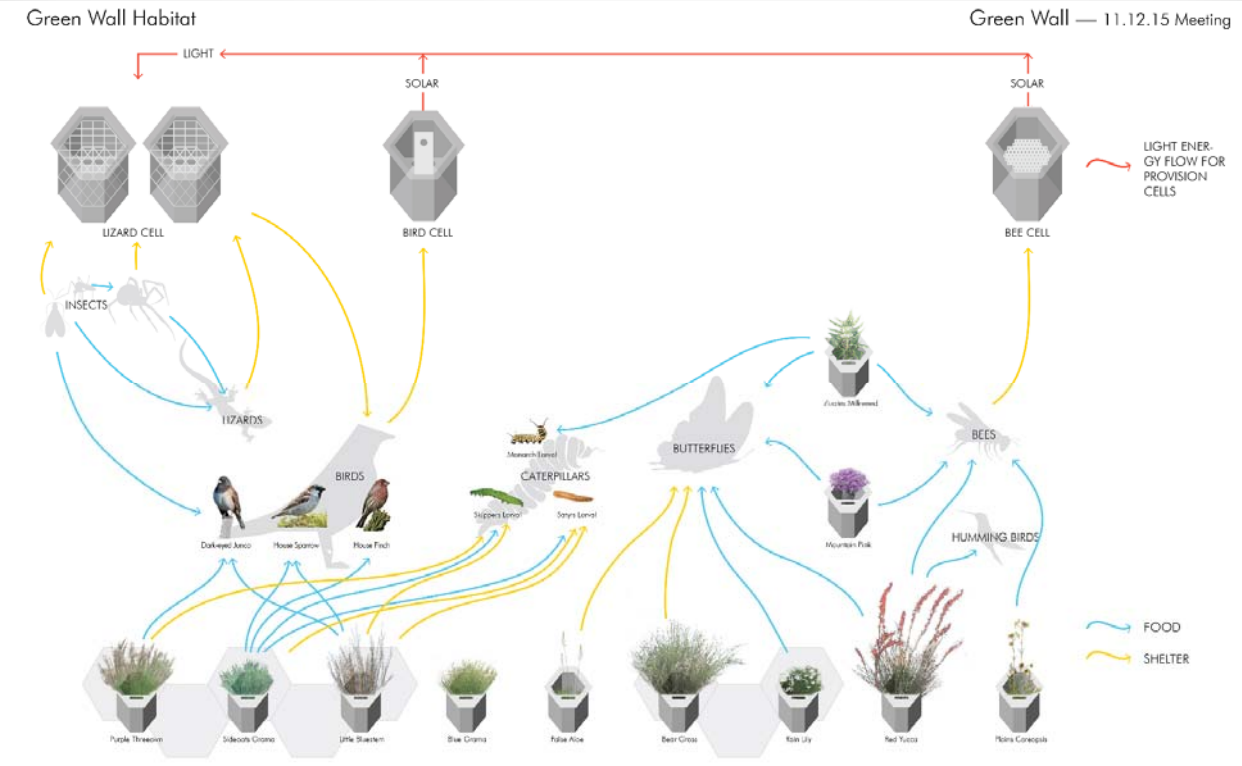
Analytical Properties
View: 3D View: {3D}1
Preview >>
OK
Cancel
Apply



Green Garage Plant Schedule

Plant Type	Plant Name	Scientific Name	Habit	Unit Depth	Soil Depth	Soil Description	Soil Moisture	Soil Drainage	Count	Cost	Total Cost
Plant 1	Coral Honeysuckle	Cissus trifoliata	Herbacious Vine	0' - 6"	M	V	M	SD	330	4.00	1320
Plant 2	Alamo Vine	Merremia dissecta	Herbacious Vine	0' - 6"	M	V	MD	SD	510	4.00	2040
Plant 3	Cross Vine	Bignonia capreolata	Vaiable Vine	0' - 6"	M	V	MD	WDO	592	4.00	2368
Plant 4	Sideoats Gramma	Bouteloua curtipendula	Grass	0' - 6"	R	V	MD	WDO, SD	582	1.00	582
Plant 5	Red Yucca	Hesperaloe parviflora	Succulent	0' - 6"	M	V	D	WD	556	15.00	8340
Plant 6	False Aloe	Manfreda maculosa	Succulent	0' - 6"	R	V	D	WD	504	4.00	2016
Plant 7	Chisme	Portulaca pulosa	Succulent	0' - 6"	R	V	D	WD	560	4.00	2240
Plant 8	Little Bluestem	Schizacyrium scoparium	Grass	0' - 6"	R	V	MD	WD	514	20.00	10280
Plant 9	Bear Grass	Nolina sp	Grass	0' - 6"	R	V	D	WD	510	4.00	2040
Plant 10	Gregg's Dalea	Dalea greggii	Shrub	0' - 6"	R	Clay Loam	D	WD	382	15.00	5730
Plant 11	Buffalo Grass	Buchloe dactyloides	Grass	0' - 6"	R	Clay Loam	D	SD	160	4.00	640
Plant 12	Spineless Prickly Pear	Opuntia ellisiana	Succulent	0' - 6"	R	V	D	WDO	68	20.00	1360
0' - 6"									5268		38956
Plant 1	Coral Honeysuckle	Cissus trifoliata	Herbacious Vine	1' - 3"	M	V	M	SD	290	4.00	1160
Plant 2	Alamo Vine	Merremia dissecta	Herbacious Vine	1' - 3"	M	V	MD	SD	392	4.00	1568
Plant 3	Cross Vine	Bignonia capreolata	Vaiable Vine	1' - 3"	M	V	MD	WDO	466	4.00	1864
Plant 4	Sideoats Gramma	Bouteloua curtipendula	Grass	1' - 3"	R	V	MD	WDO, SD	440	1.00	440
Plant 5	Red Yucca	Hesperaloe parviflora	Succulent	1' - 3"	M	V	D	WD	452	15.00	6780
Plant 6	False Aloe	Manfreda maculosa	Succulent	1' - 3"	R	V	D	WD	458	4.00	1832
Plant 7	Chisme	Portulaca pulosa	Succulent	1' - 3"	R	V	D	WD	514	4.00	2056
Plant 8	Little Bluestem	Schizacyrium scoparium	Grass	1' - 3"	R	V	MD	WD	508	20.00	10160
Plant 9	Bear Grass	Nolina sp	Grass	1' - 3"	R	V	D	WD	386	4.00	1544
Plant 10	Gregg's Dalea	Dalea greggii	Shrub	1' - 3"	R	Clay Loam	D	WD	286	15.00	4290
Plant 11	Buffalo Grass	Buchloe dactyloides	Grass	1' - 3"	R	Clay Loam	D	SD	198	4.00	792
Plant 12	Spineless Prickly Pear	Opuntia ellisiana	Succulent	1' - 3"	R	V	D	WDO	38	20.00	760
1' - 3"									4428		33246
Plant 1	Coral Honeysuckle	Cissus trifoliata	Herbacious Vine	2' - 6"	M	V	M	SD	26	4.00	104
Plant 2	Alamo Vine	Merremia dissecta	Herbacious Vine	2' - 6"	M	V	MD	SD	24	4.00	96
Plant 3	Cross Vine	Bignonia capreolata	Vaiable Vine	2' - 6"	M	V	MD	WDO	32	4.00	128
Plant 4	Sideoats Gramma	Bouteloua curtipendula	Grass	2' - 6"	R	V	MD	WDO, SD	8	1.00	8
Plant 5	Red Yucca	Hesperaloe parviflora	Succulent	2' - 6"	M	V	D	WD	10	15.00	150
Plant 6	False Aloe	Manfreda maculosa	Succulent	2' - 6"	R	V	D	WD	18	4.00	72
Plant 7	Chisme	Portulaca pulosa	Succulent	2' - 6"	R	V	D	WD	18	4.00	72
Plant 8	Little Bluestem	Schizacyrium scoparium	Grass	2' - 6"	R	V	MD	WD	10	20.00	200
Plant 9	Bear Grass	Nolina sp	Grass	2' - 6"	R	V	D	WD	6	4.00	24
Plant 10	Gregg's Dalea	Dalea greggii	Shrub	2' - 6"	R	Clay Loam	D	WD	12	15.00	180
2' - 6"									164		1034
Grand total: 9860									9860		73236

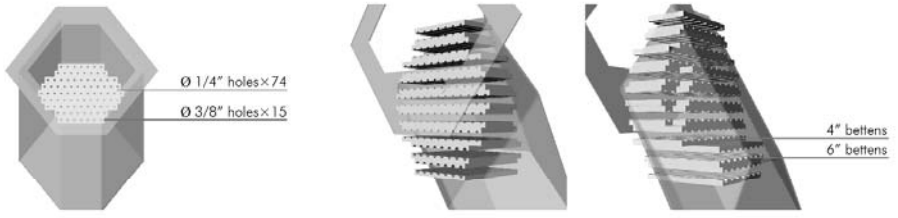

Green Wall Habitat
Green Wall — 11.12.15 Meeting
LIGHT
SOLAR
SOLAR
LIZARD CELL
BIRD CELL
BEE CELL
LIGHT ENER-
GY FLOW FOR
PROVISION
CELLS
INSECTS
LIZARDS
BIRDS
CATERPILLARS
BUTTERFLIES
BEES
HUMMING BIRDS
FOOD
SHELTER


Planting Cells
Green Wall — 11.12.15 Meeting
3′
2′
1′
0′
Little Bluestem
Sideoats Grama
Purple Threeawn
Blue Grama
American Fiveminute Grass
Red Yucca
Bear Grass
False Aloe
Zizotes Milkweed
Plains Coreopsis
Yellow Stonecrop
Mountain Pink
Rain Lily

Provision Cells

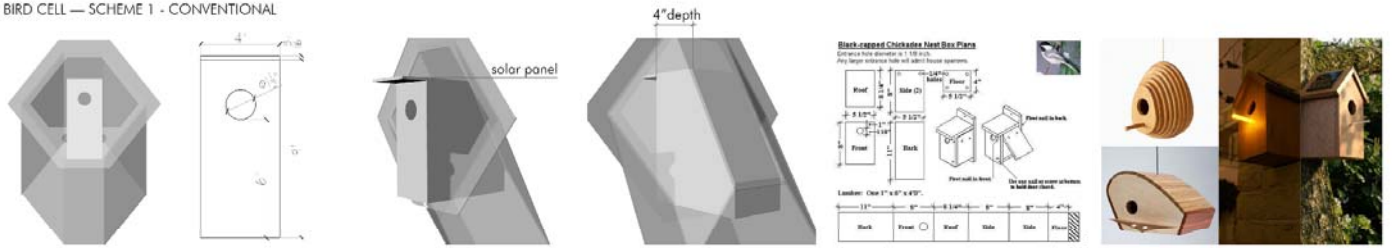
Green Wall — 11.12.15 Meeting

BEE CELL — SCHEME 1 - BATTEN

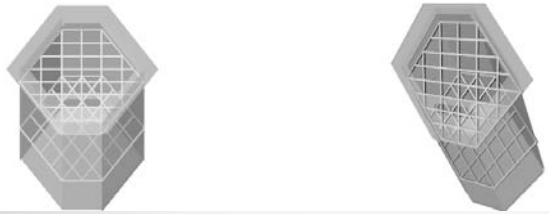


BEE CELL — SCHEME 2 - BAMBOO

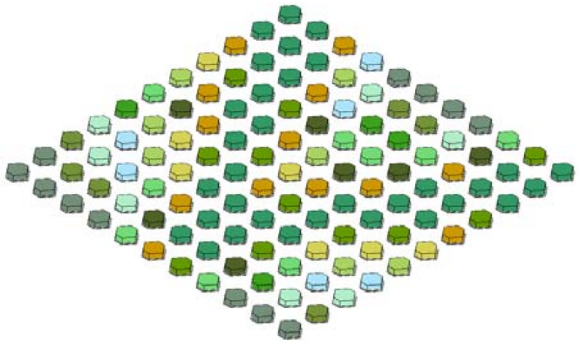
BIRD CELL — SCHEME 1 - CONVENTIONAL

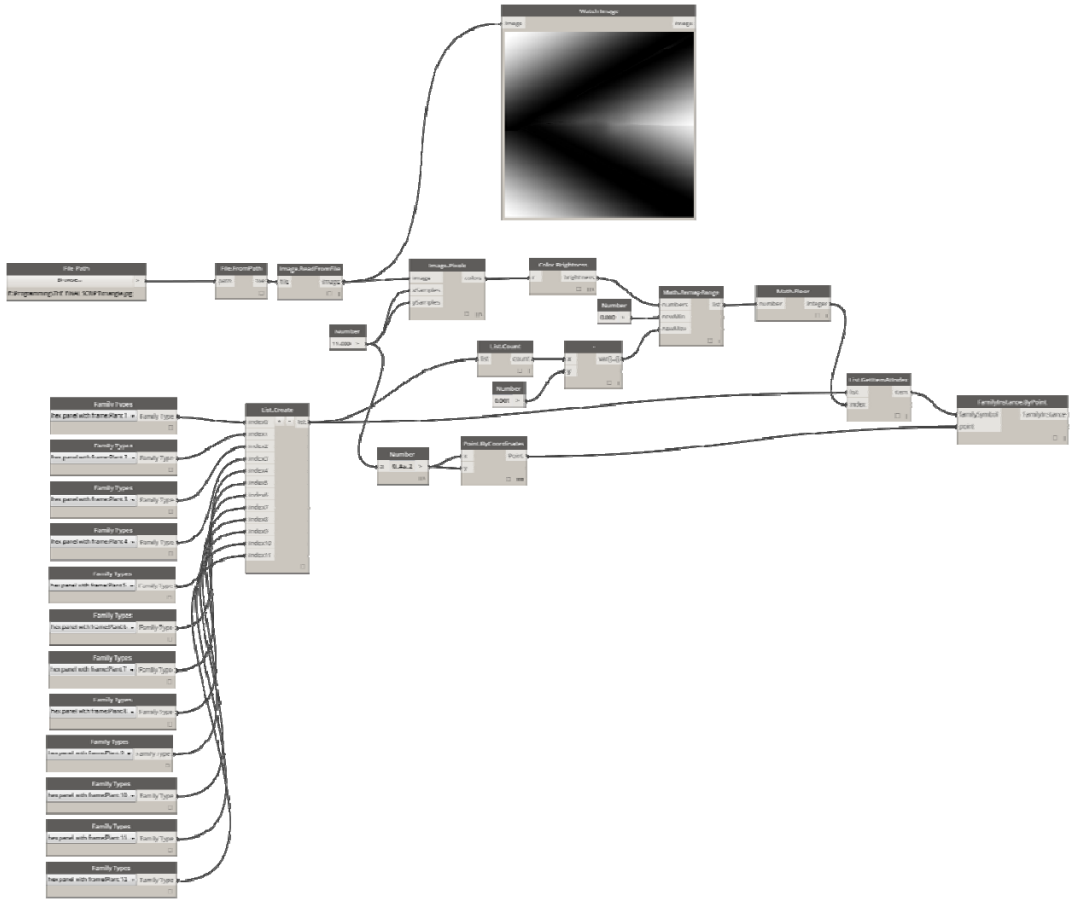


LIZARD CELL — SCHEME 1 - TWIST TWIG



PROVISION CELL — SCHEME 2 - BARK SHINGLE WITH LIGHT

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Math.Floor
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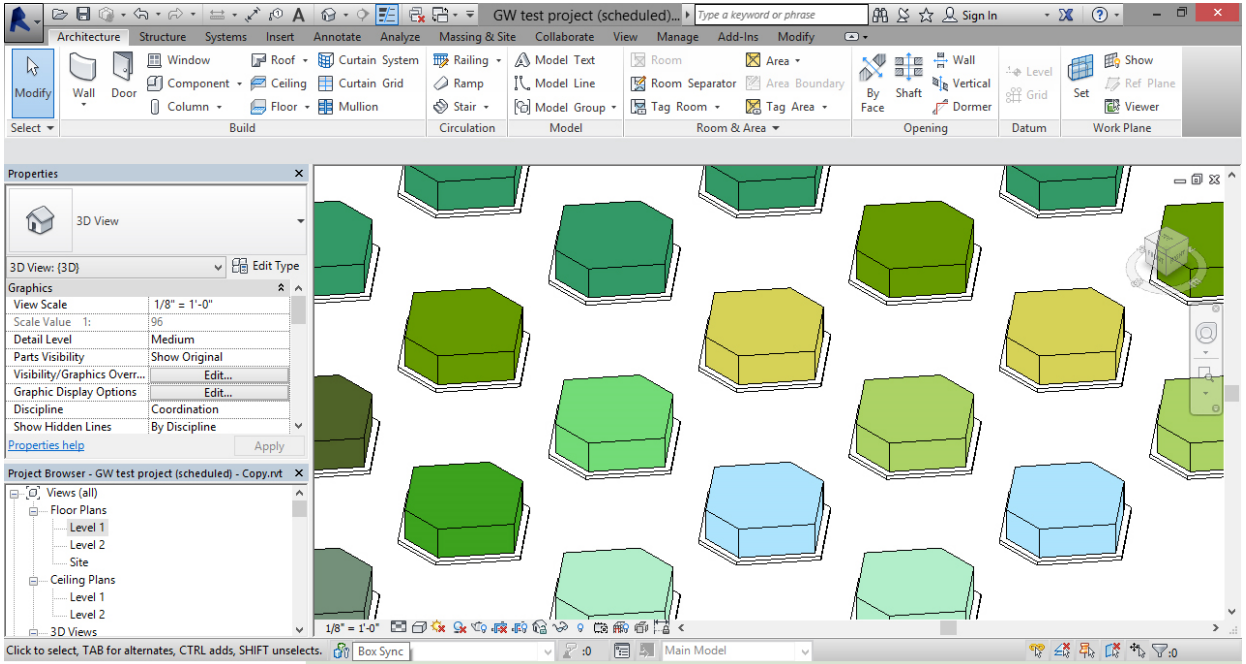
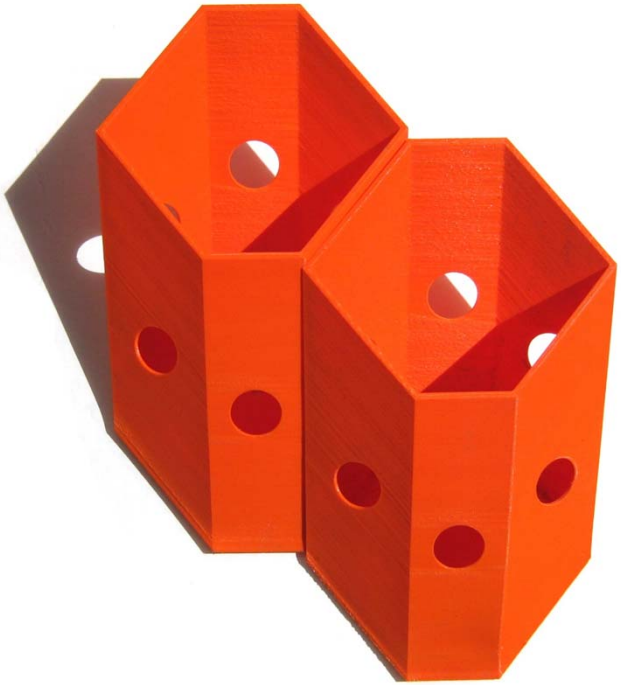


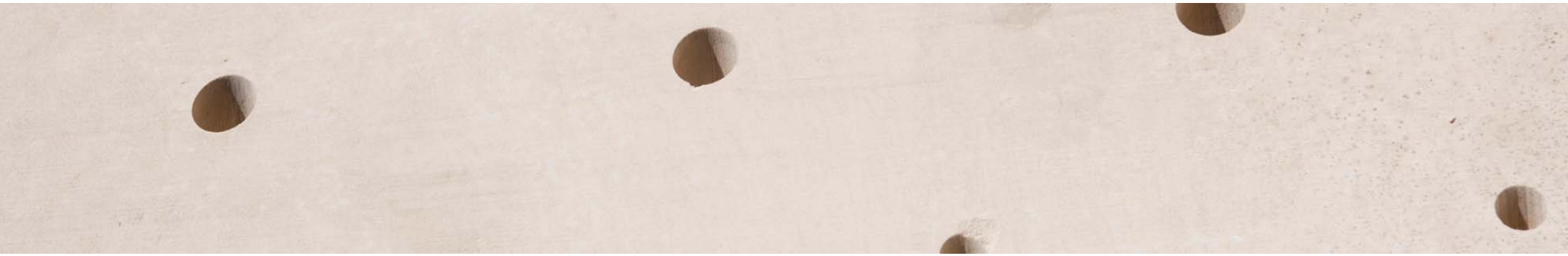
<Green Garage Plant Schedule>

A	B	C	D	E	F	G	H	I	J
Plant Type	Plant Name	Scientific Name	Habit	Unit Depth	Soil De	Soil Description	Soil Moisture	Soil Drainage	Count
Plant 1	Coral Honeysuckle	Cissus trifoliata	Herbacious Vine	0' - 6"		V	M	SD	32
Plant 2	Alamo Vine	Merremia dissecta	Herbacious Vine	0' - 6"		V	MD	SD	11
Plant 3	Cross Vine	Bignonia capreolata	Vaiable Vine	0' - 6"		V	MD	WDO	13
Plant 4	Sideoats Gramma	Bouteloua curtipendula	Grass	0' - 6"		V	MD	WDO, SD	7
Plant 5	Red Yucca	Hesperaloe parviflora	Succulent	0' - 6"		V	D	WD	7
Plant 6	False Aloe	Manfreda maculosa	Succulent	0' - 6"		V	D	WD	7
Plant 7	Chisme	Portulaca pulosa	Succulent	0' - 6"		V	D	WD	9
Plant 8	Little Bluestem	Schizacyrium scoparium	Grass	0' - 6"		V	MD	WD	6
Plant 9	Bear Grass	Nolina sp	Grass	0' - 6"		V	D	WD	4
Plant 10	Gregg's Dalea	Dalea greggii	Shrub	0' - 6"		Clay - loam	D	WD	7
Plant 11	Buffalo Grass	Schizacyrium scoparium	Grass	0' - 6"		V	MD	WD	6
Plant 12	Spineless Prickly Pear	Schizacyrium scoparium	Grass	0' - 6"		V	MD	WD	12
Grand total: 121									121



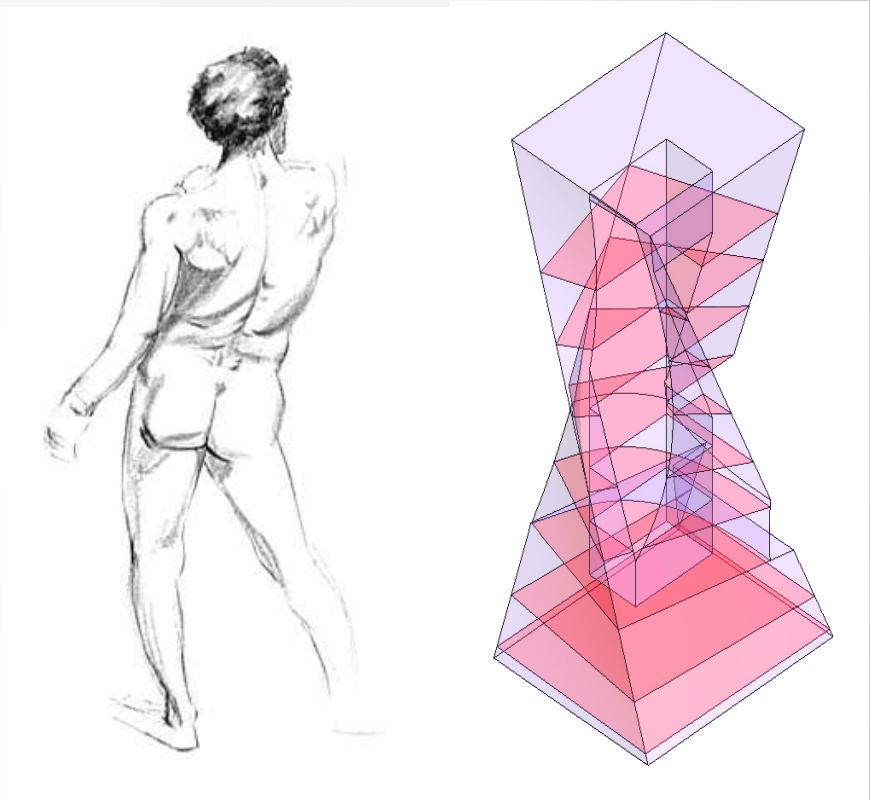

IRRIGATION
AND WATER
CONSERVATION

Facilitate digital fabrication in building design



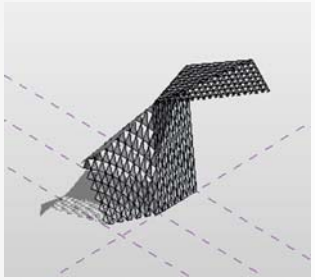
Beauty + the BIM

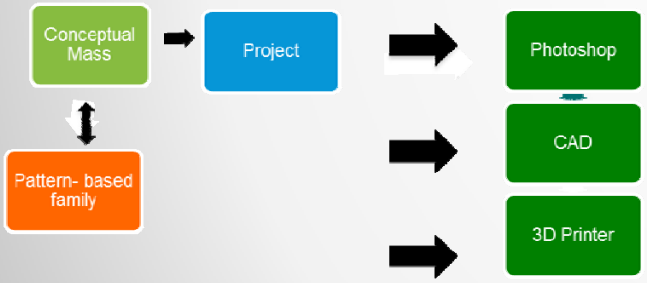
- **Unitec New Zealand, Auckland, NZ**
  2005-2009

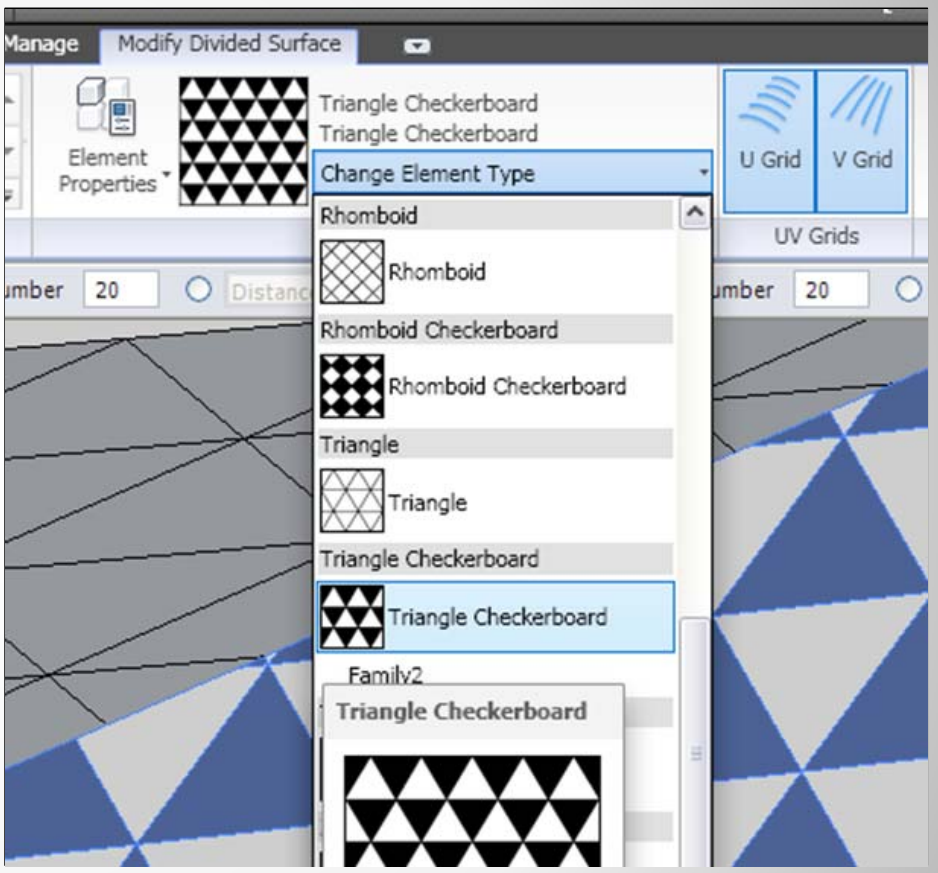


Beauty + the BIM

- **Unitec New Zealand, Auckland, NZ**
  2005-2009

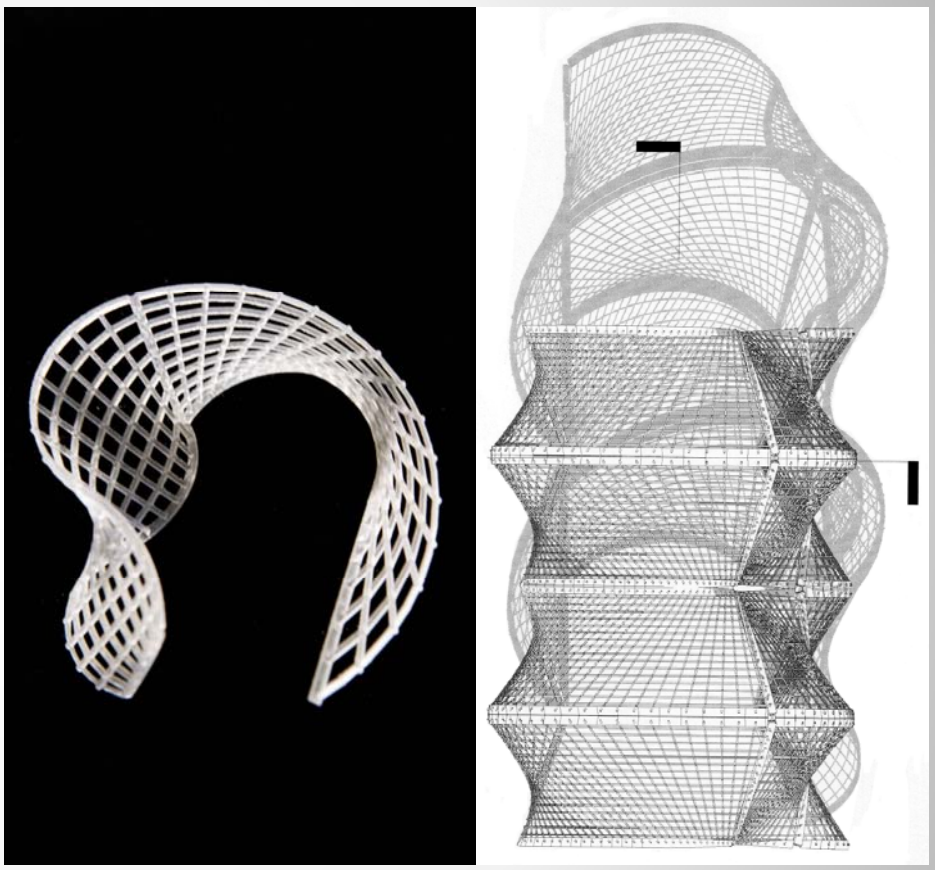






Beauty + the BIM

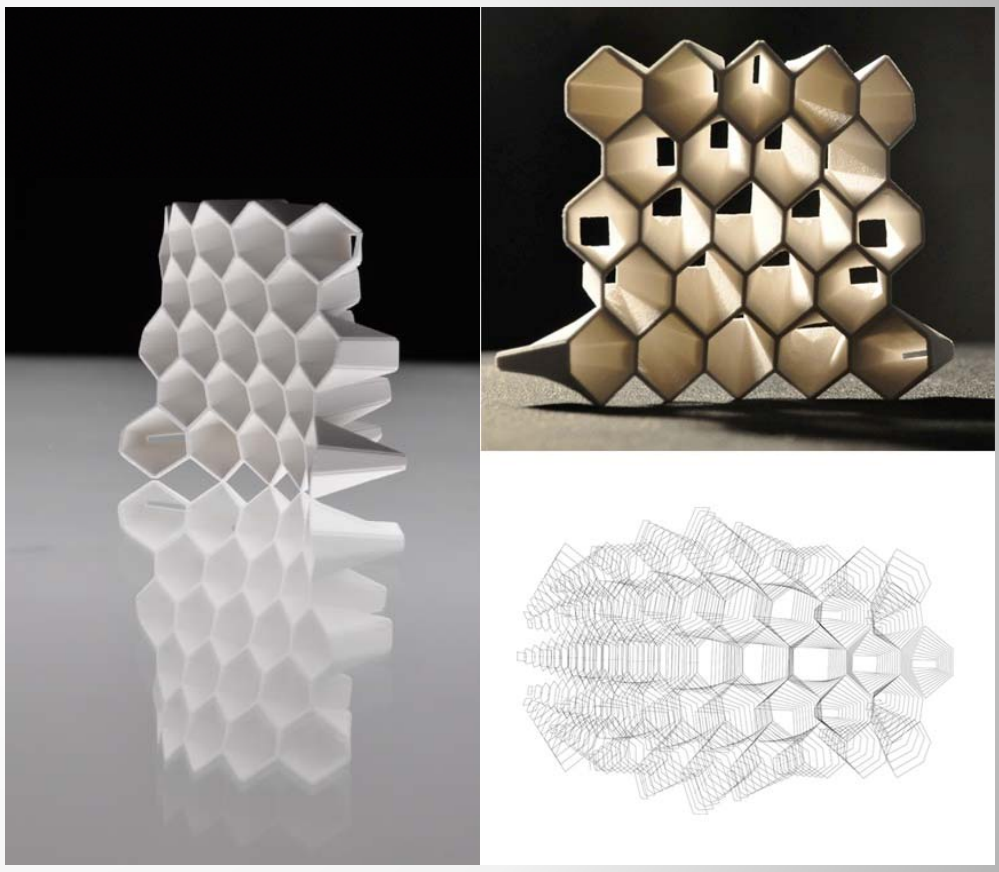
- **Unitec New Zealand, Auckland, NZ**
  2005-2009



Lucianno Velocci

Beauty + the BIM

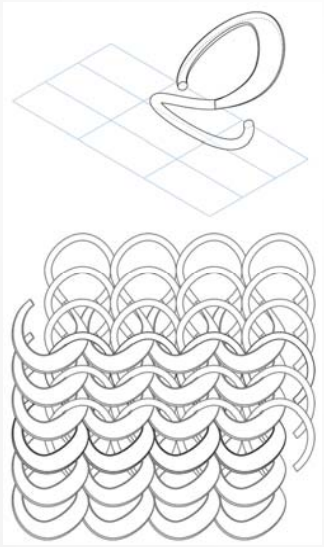
- **University of Texas, Austin, TX**
  2009-2010



Blake Smith

Beauty + the BIM

- **University of Texas, Austin, TX**
  2009-2010

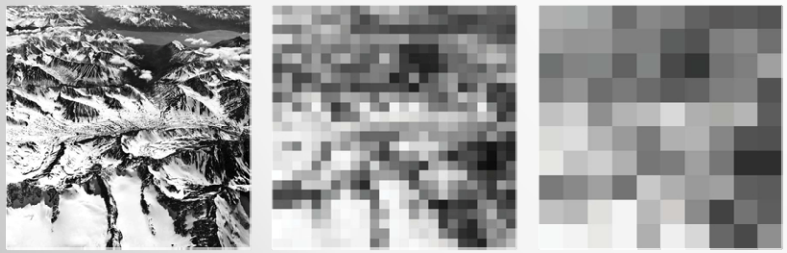


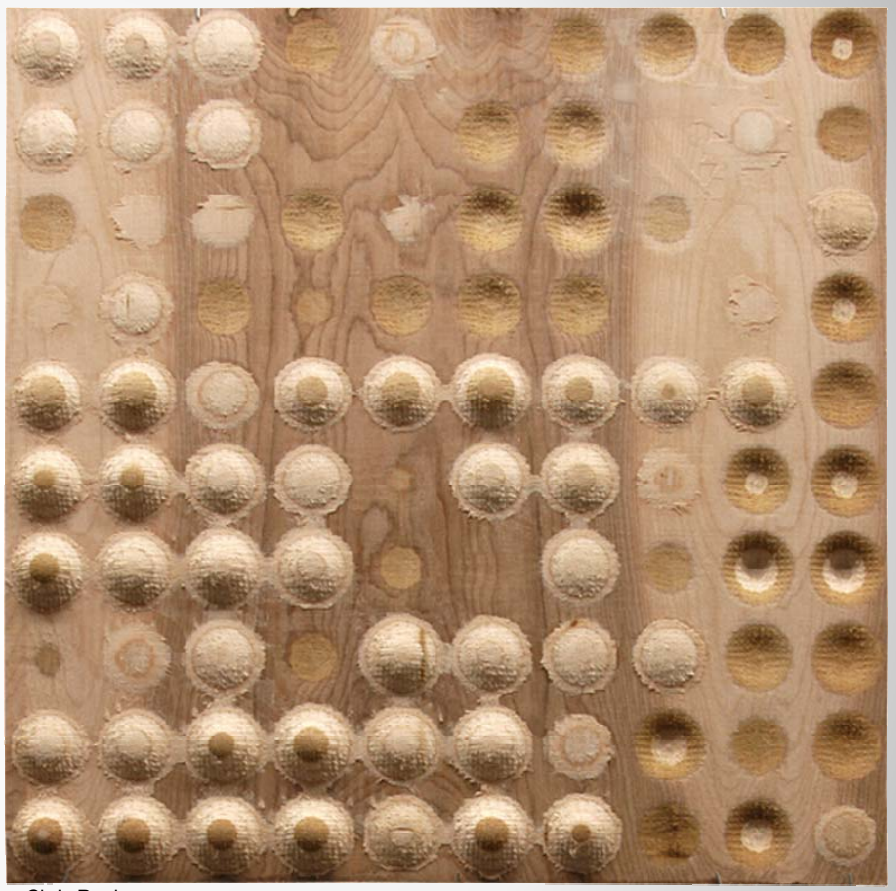
Seth Brunner

Beauty + the BIM

- **University of Texas, Austin, TX**
  2009-2010

- Realistic expectations
- 20”x20” CNC panels
- Celebrates plywood layering

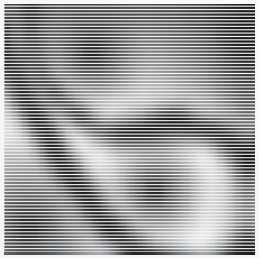


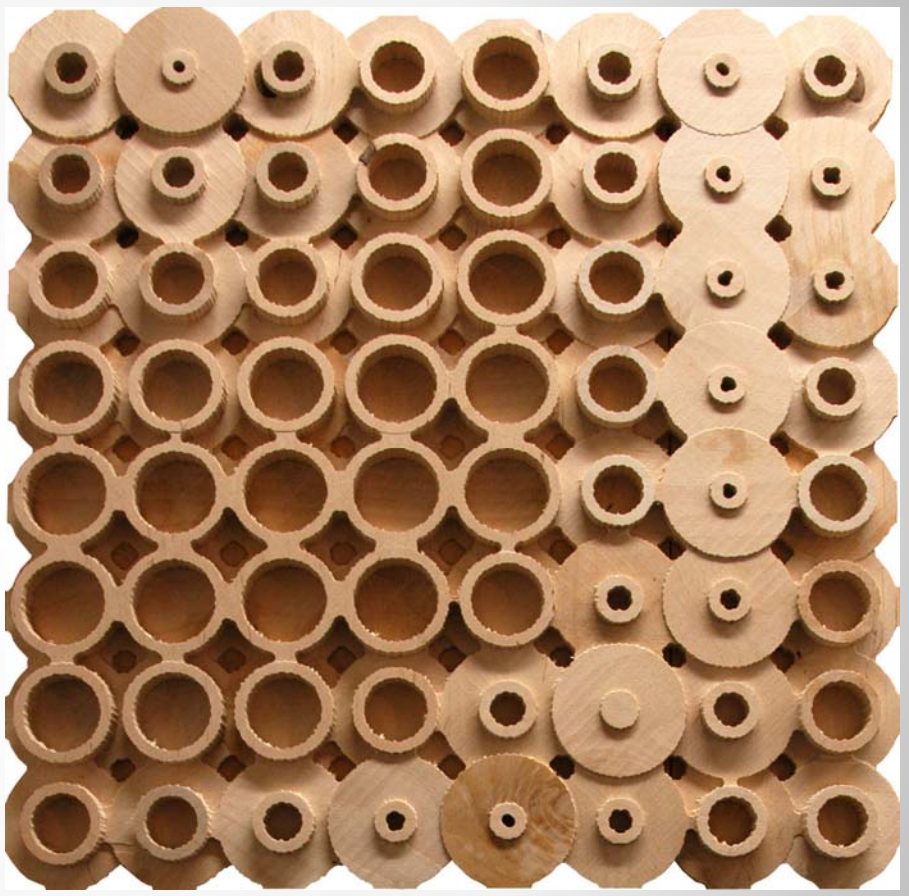


Chris Renke

Beauty + the BIM

- **University of Texas, Austin, TX**
  2009-2010

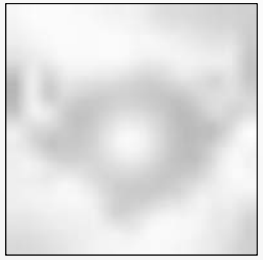


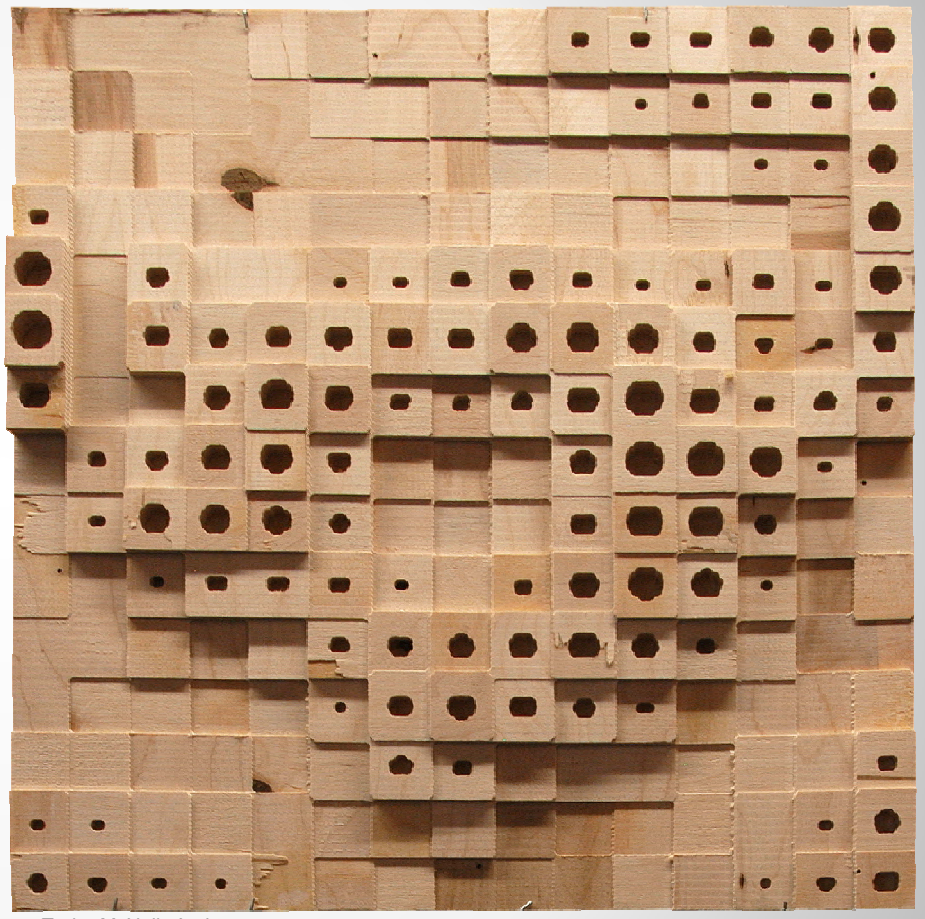


Judson Garwood

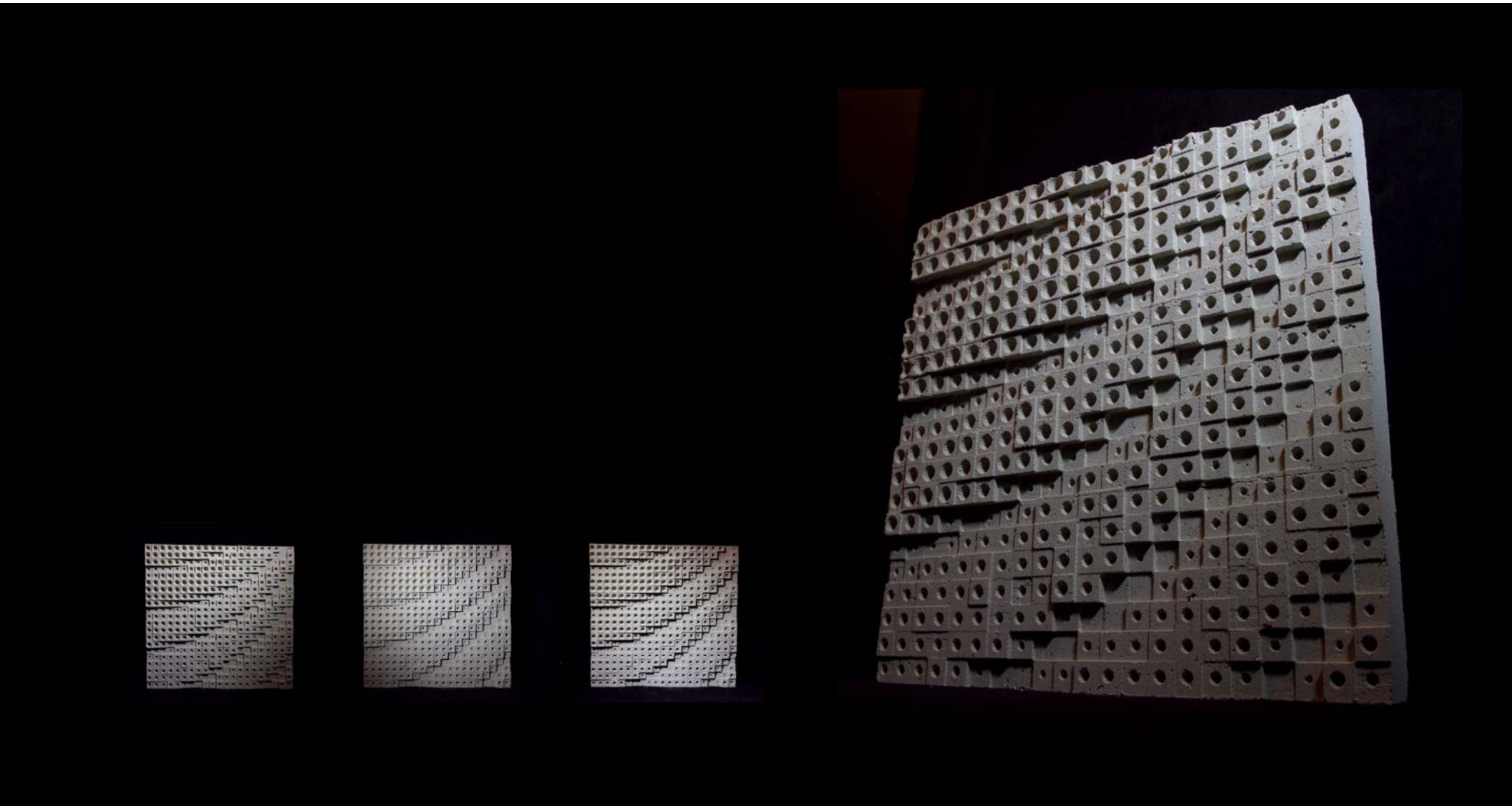
Beauty + the BIM

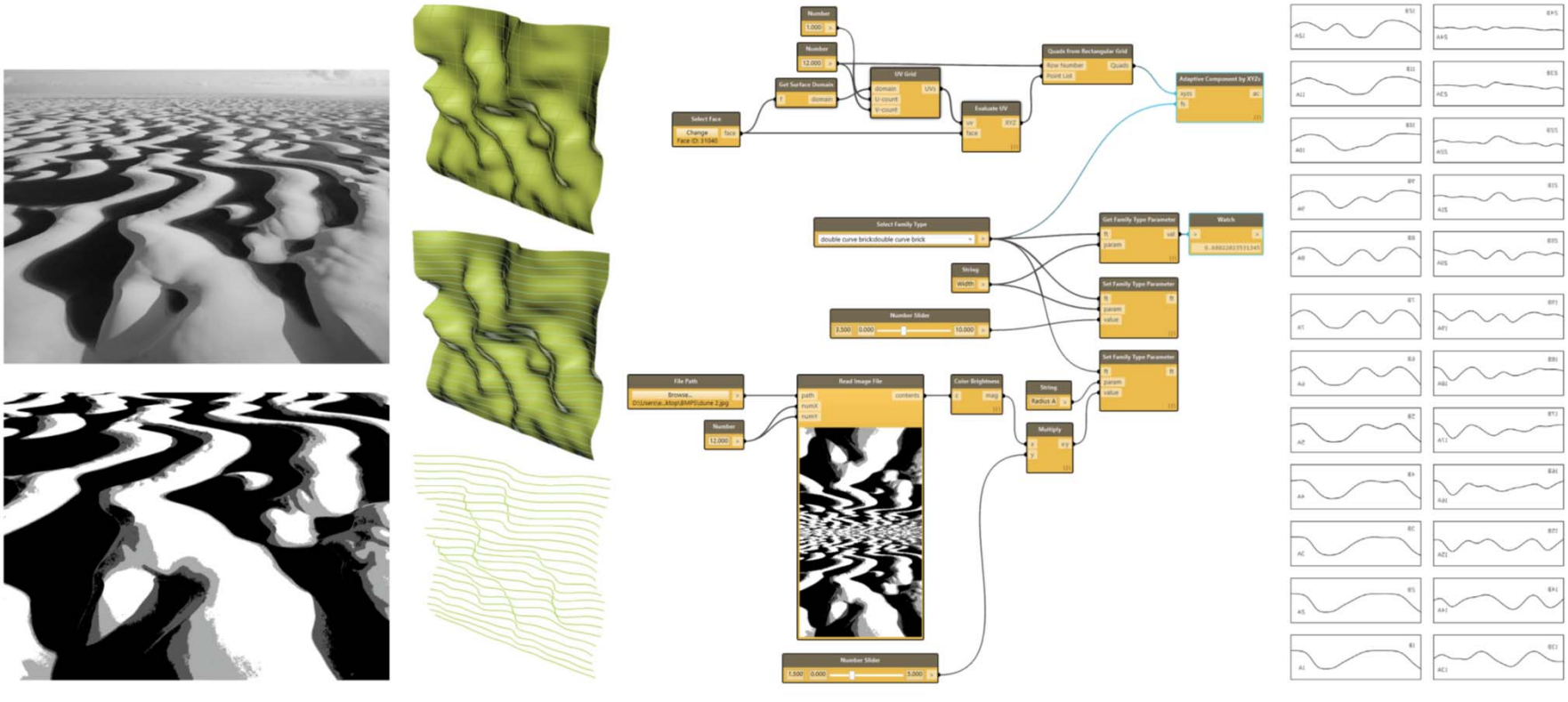
- **University of Texas, Austin, TX**
  2009-2010



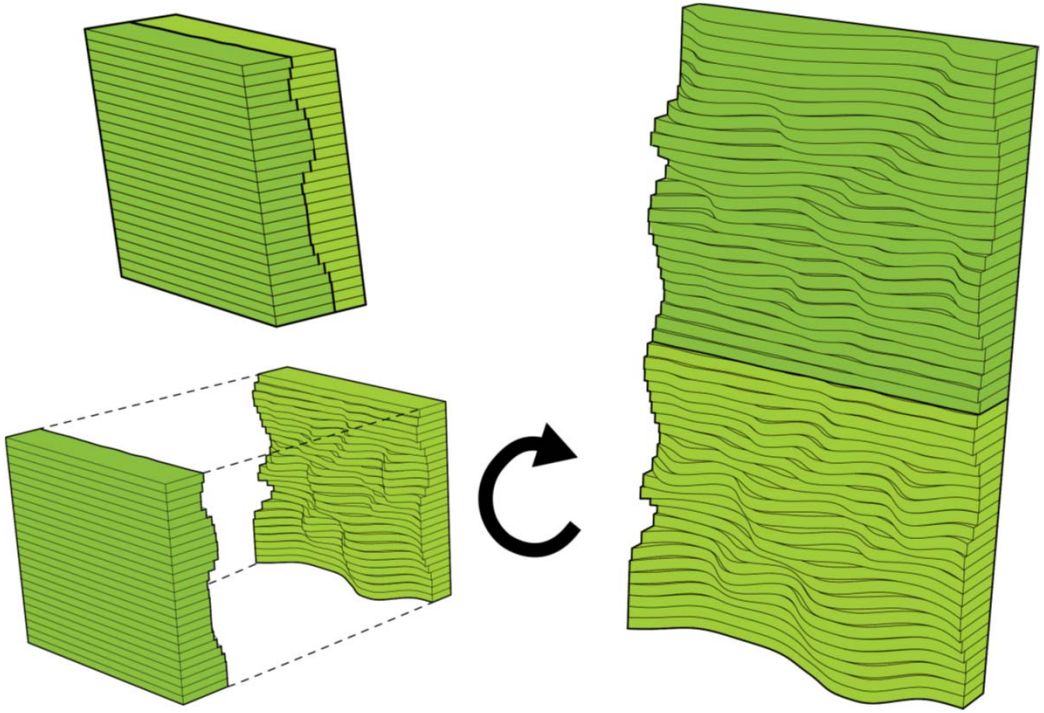


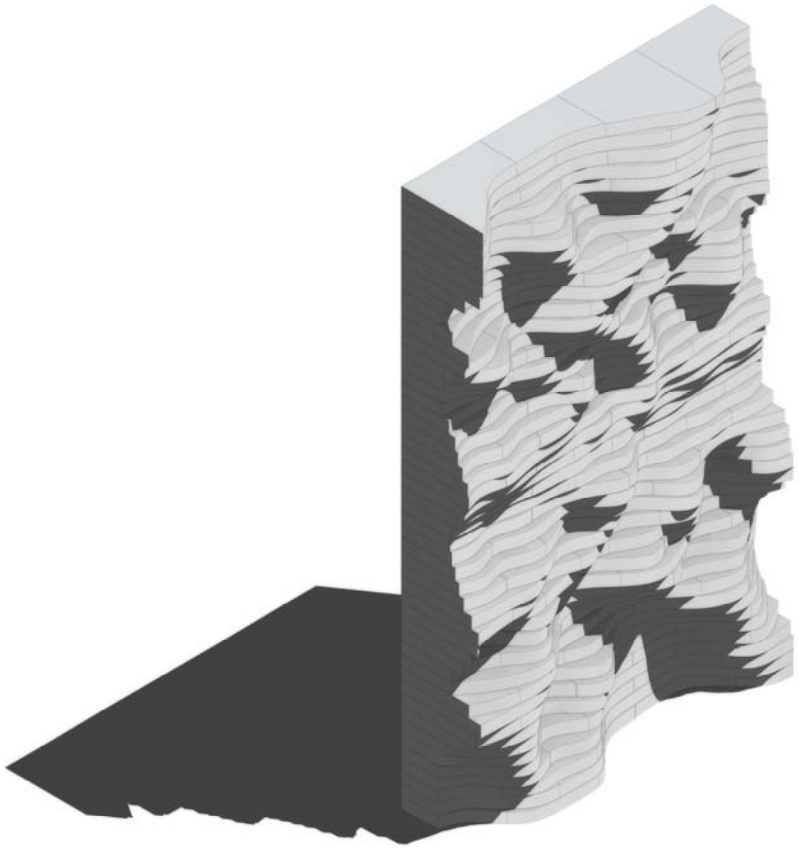
Taylor McNally Anderson

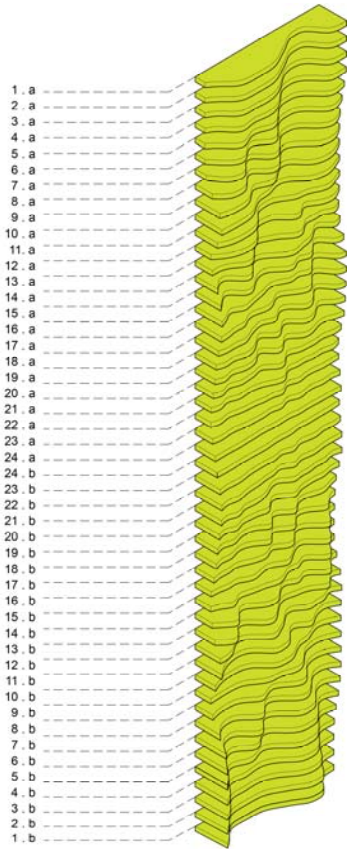




Ethan Bennett, John Cunningham, April Ng



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Information Controlled Erosion

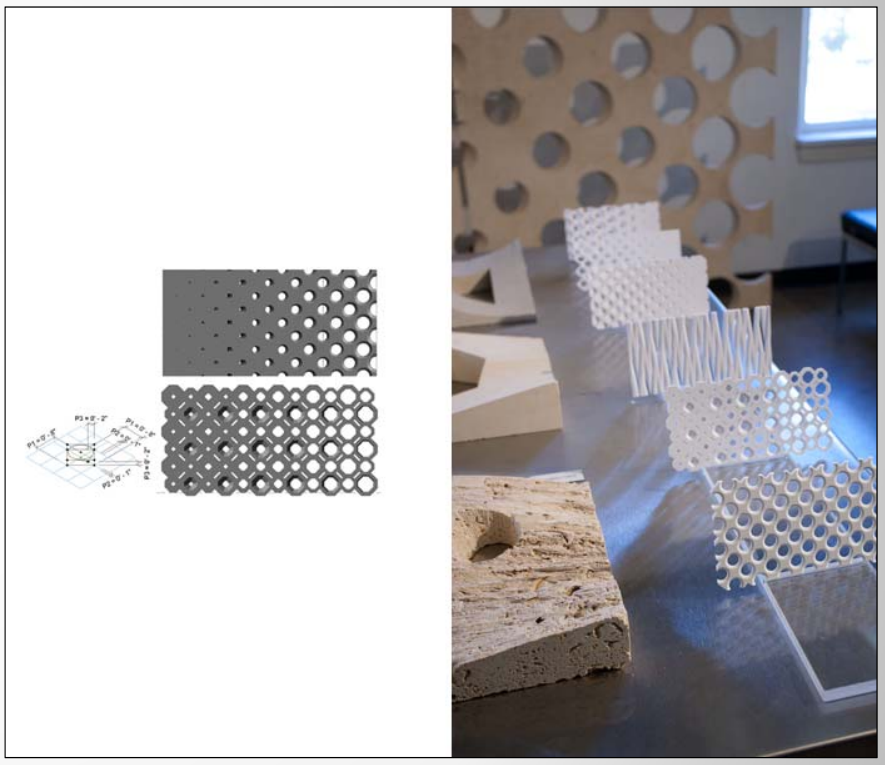
the use of **Revit** (BIM) to design, analyze and directly fabricate a full-scale limestone building mass

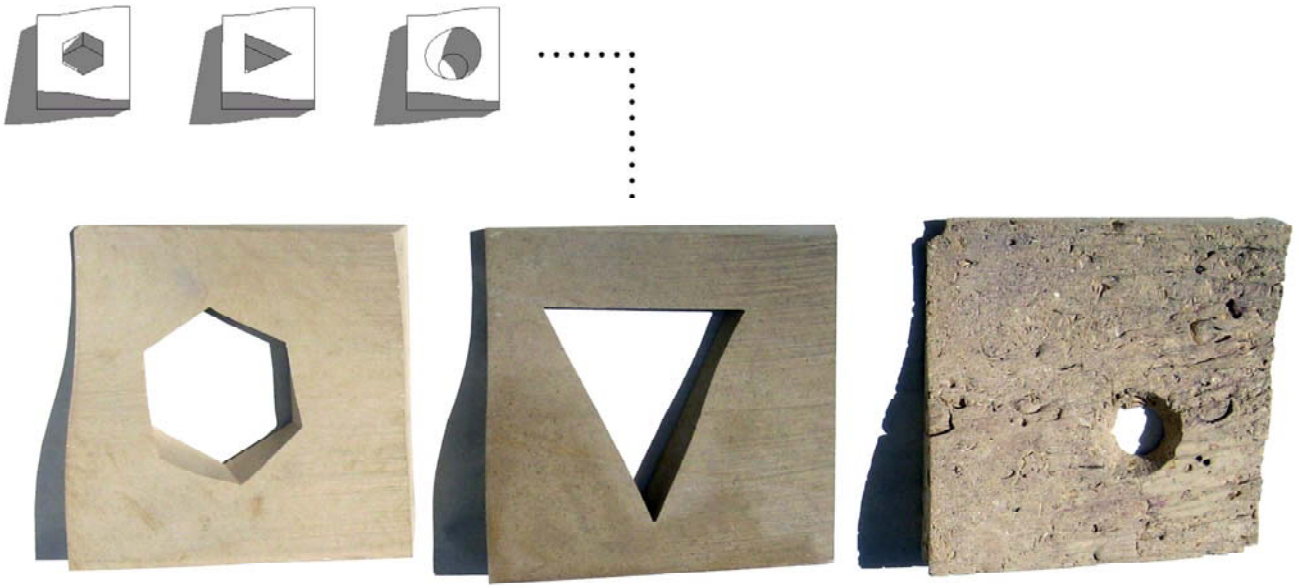
design tool in conjunction with advanced water jet 5 axis (CNC) fabrication

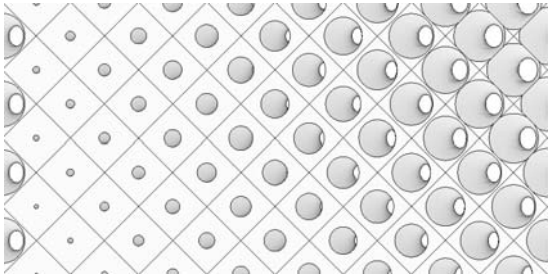
Image courtesy of Danelle Briscoe

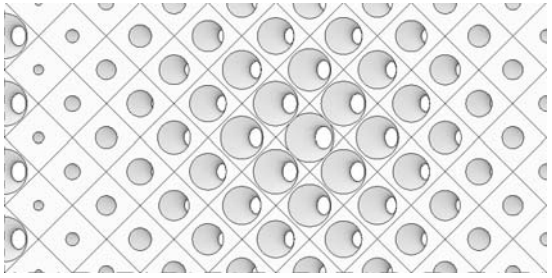
Information Controlled Erosion

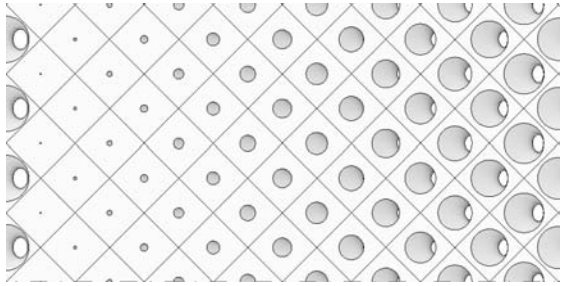
- Fabrication Settings
  - 030 nozzle used (= 1/30,000 of an inch)
  - amount of garnet (additive) depends on material being cut
  - profile cut first depth of stone, takes a lot of time due to depth of cut
  - program rate (1”/minute)
  - 6” into profile cut is clean, but bottom 6” has low resolution (uneven surface)

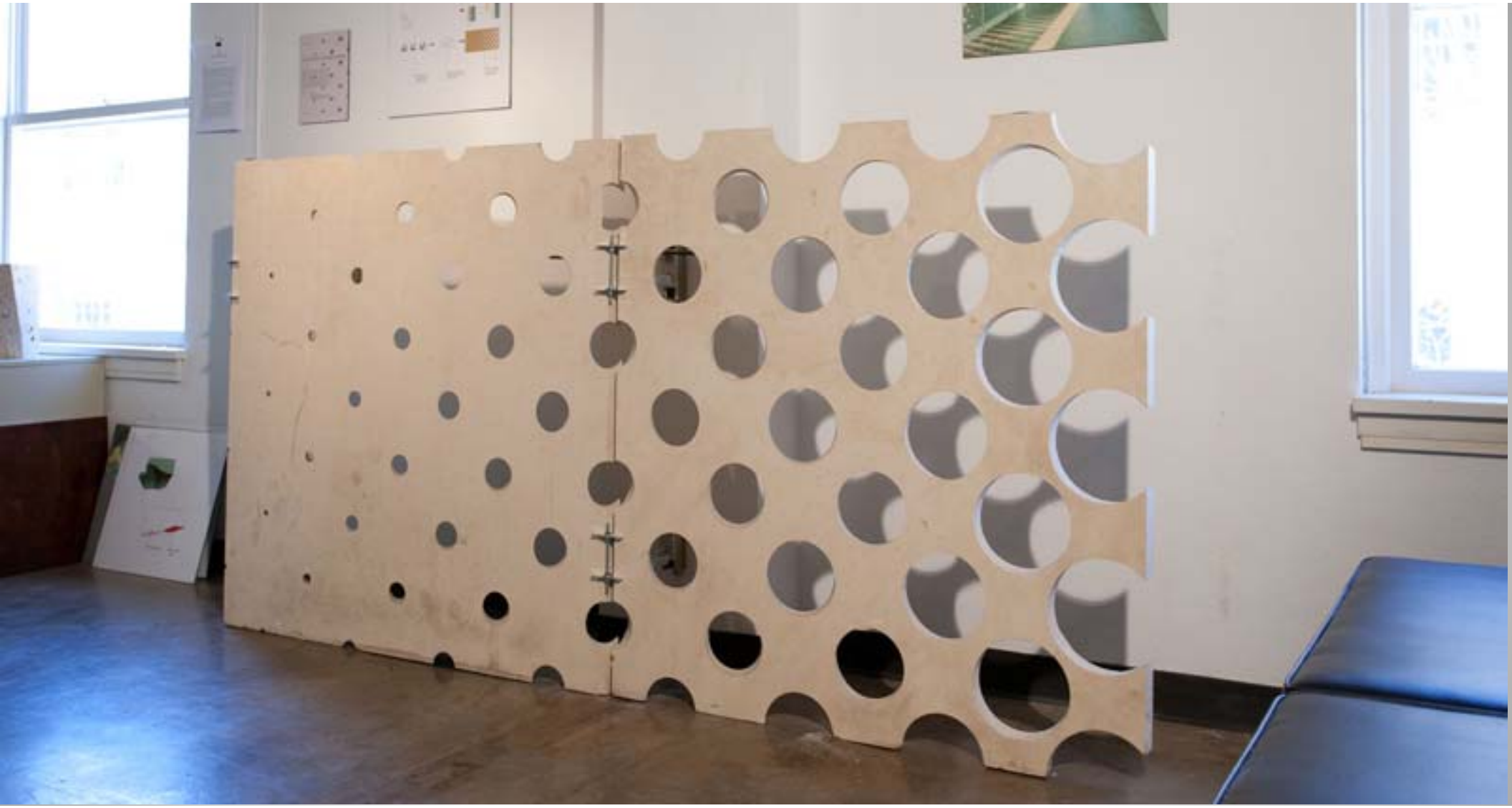




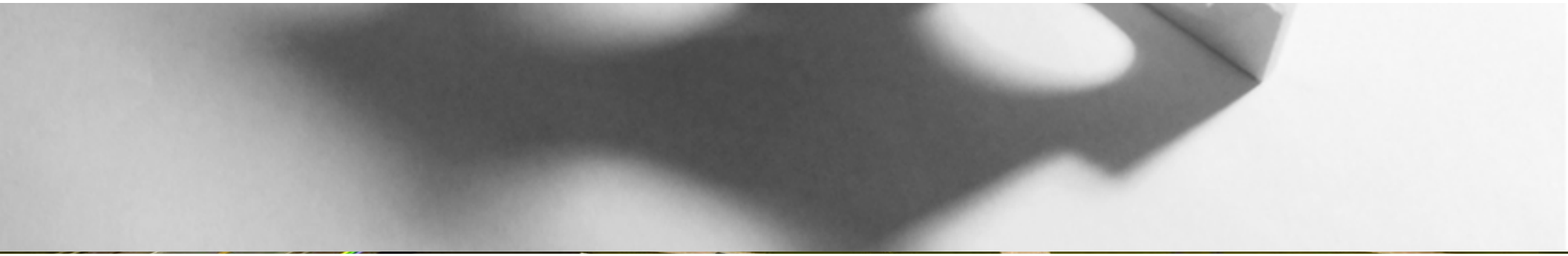









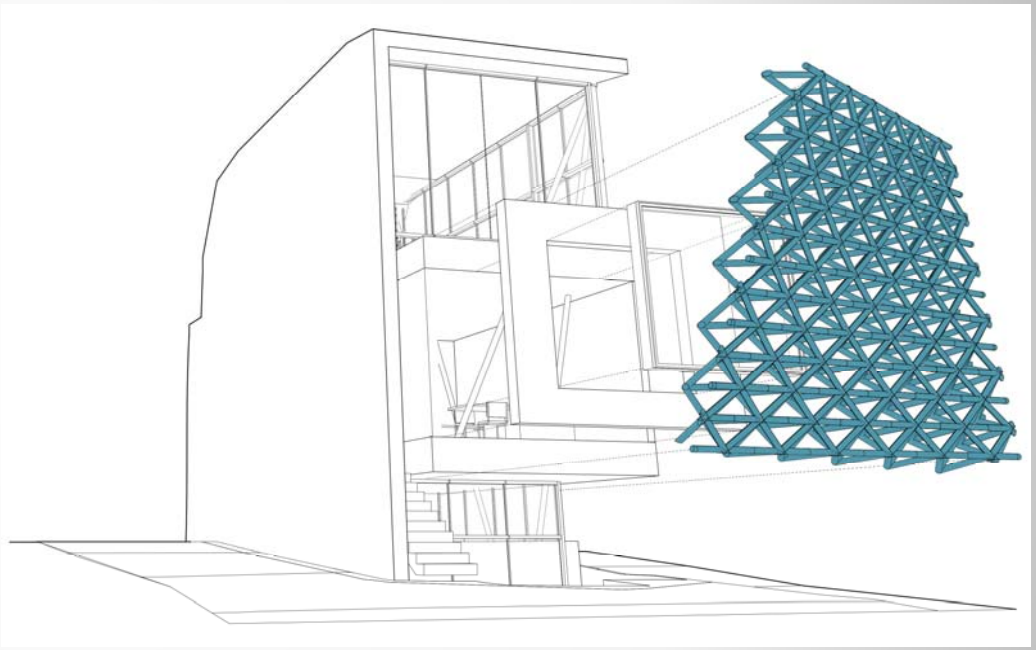
Incorporate parametric modeling into the classroom



Graduate Digital Drawing + Fabrication

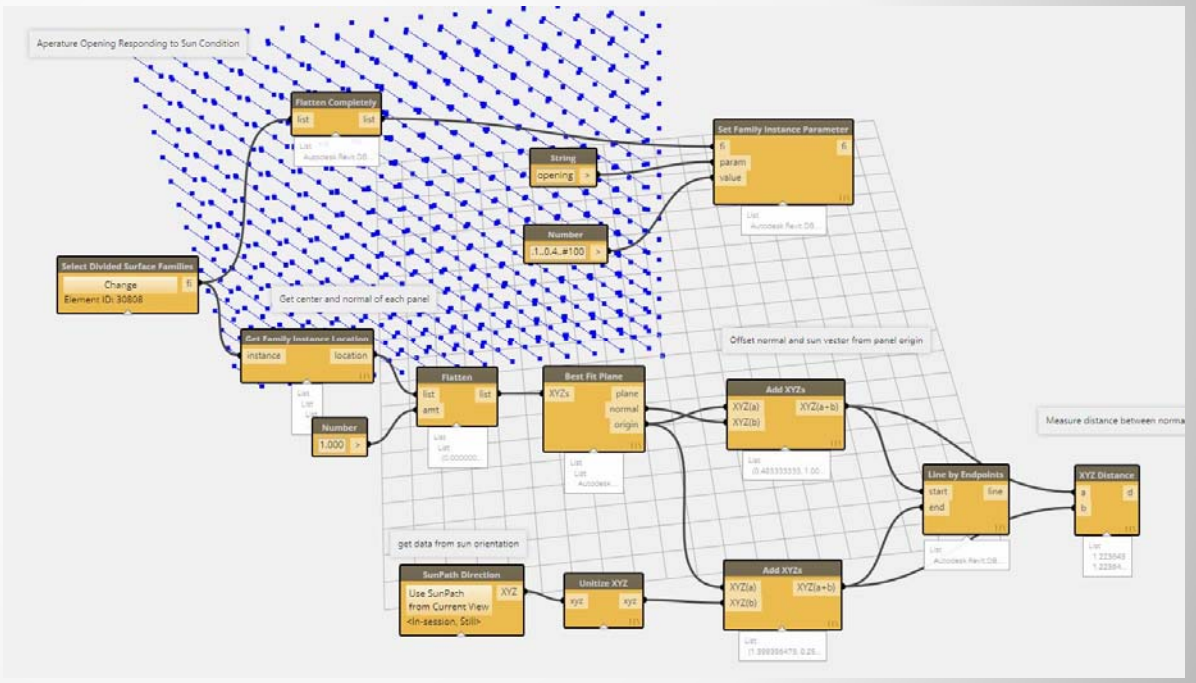
- **University of Texas**
  Austin, Texas
  Spring 2010-

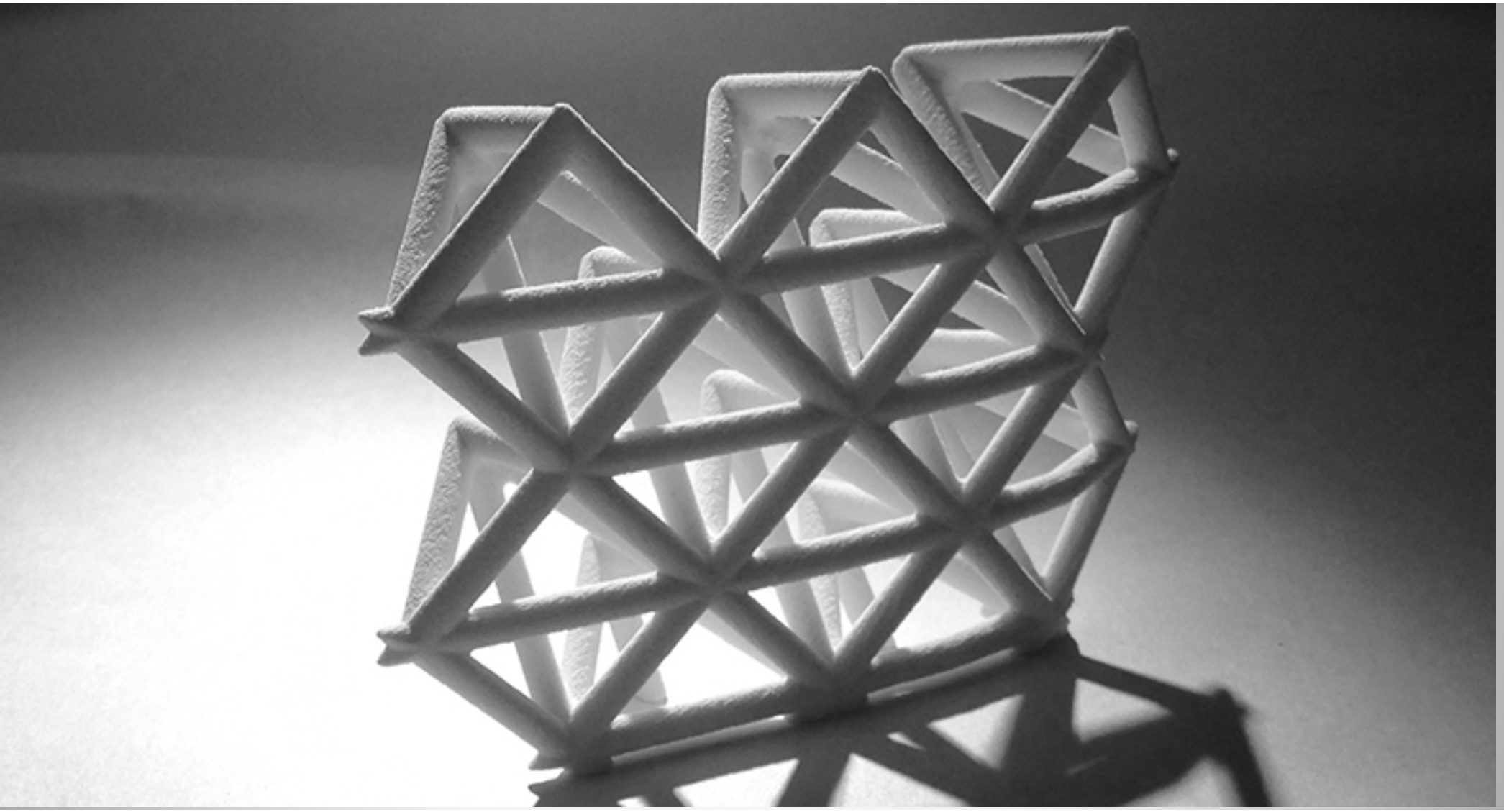
  - Tessellation Curriculum in Design Academy
  - Webinar Dynamo demonstration and video follow-ups by Reid Johnson



Graduate Digital Drawing + Fabrication

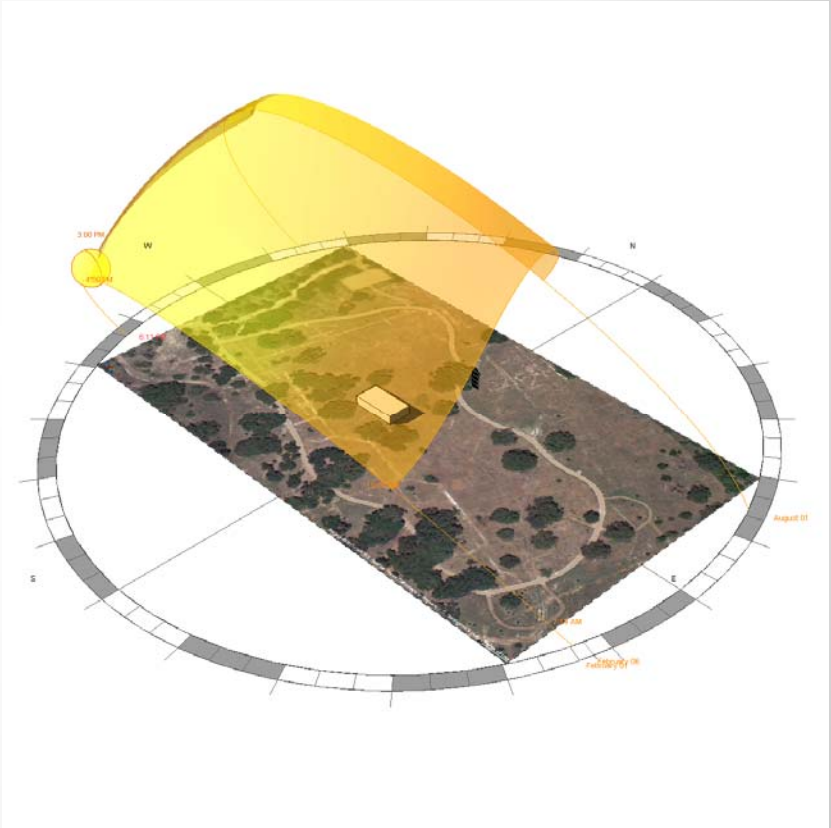
- Dynamo programming
- 3D printing

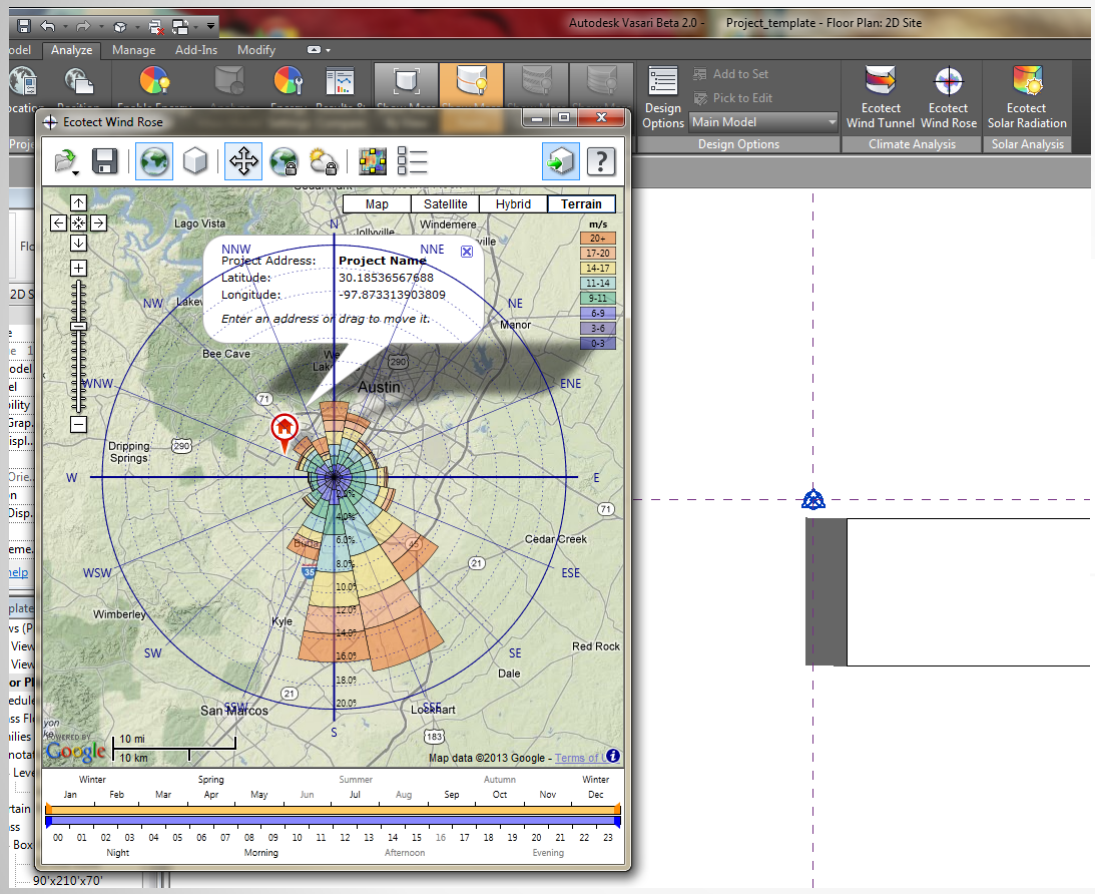


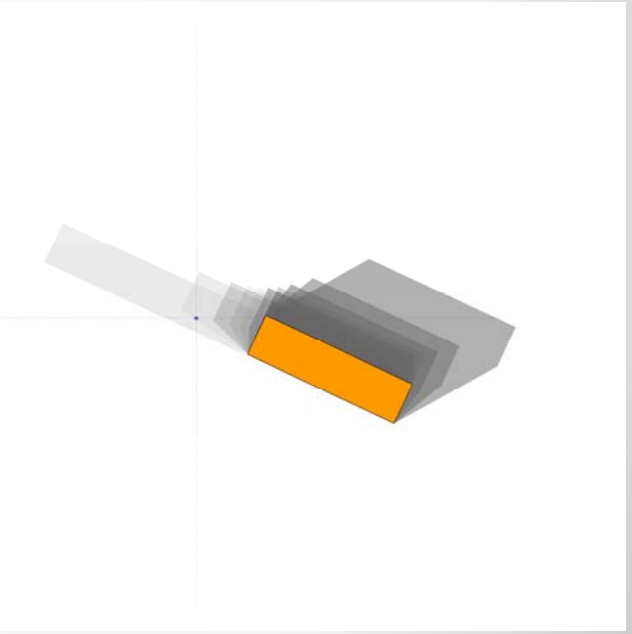


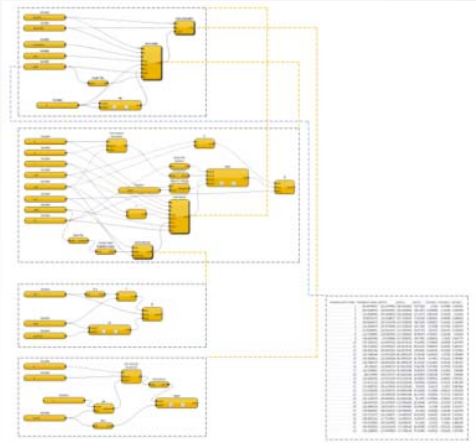
First Year Design Studio

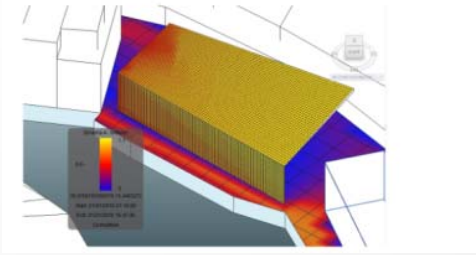
- **University of Texas**
  Austin, Texas
  Spring 2011-
  - Workshops offered for solar analysis, energy analysis, and optimization workflows in Dynamo
  - The Dynamo team at Autodesk is poised to introduce a library of solar analysis functionality




Autodesk Vasari Beta 2.0 - Project_template - Floor Plan: 2D Site
Analyze
Manage
Add-Ins
Modify
Design Options
Add to Set
Pick to Edit
Main Model
Ecotect Wind Tunnel
Ecotect Wind Rose
Ecotect Solar Radiation
Design Options
Climate Analysis
Solar Analysis
Ecotect Wind Rose
Map
Satellite
Hybrid
Terrain
Project Address:
Project Name
Latitude:
30.18536567688
Longitude:
-97.873313903809
Enter an address or drag to move it.
Austin
Lago Vista
Windemere
Bee Cave
Manor
Dripping Springs
Cedar Creek
Wimberley
Kyle
Red Rock
Dale
San Marcos
Lockhart
Map data ©2013 Google
Winter
Spring
Summer
Autumn
Winter
Night
Morning
Afternoon
Evening







VincenzoPanasiti_Design driven by solar analysis

Conclusions

- **Promote computational design skills** From the various methods using Autodesk Revit® and Dynamo shown, how can you creatively introduce these new skills into courses and curriculum ?
- **Help students with future careers** What is the call to action for future curriculums to help meet the expectations of the current climate in practice, particularly the design sector?
- **Facilitate digital fabrication in building design** how can relationships with fabricators be established early on in education using Revit and Dynamo visual programming.
- **Incorporate parametric modeling into the classroom** What is the most relevant and impactful for students; the design process, the data workflow process, or the project outcome or a combination of a few?

Additional resources

Images and video content

- http://dynamobim.com/learn/
- https://knowledge.autodesk.com/support/dynamo-studio/learn-explore/caas/video/youtube/watch-v-QETG7HaaaaI.html

Publication

- *Beyond BIM: Architecture Information Modeling*