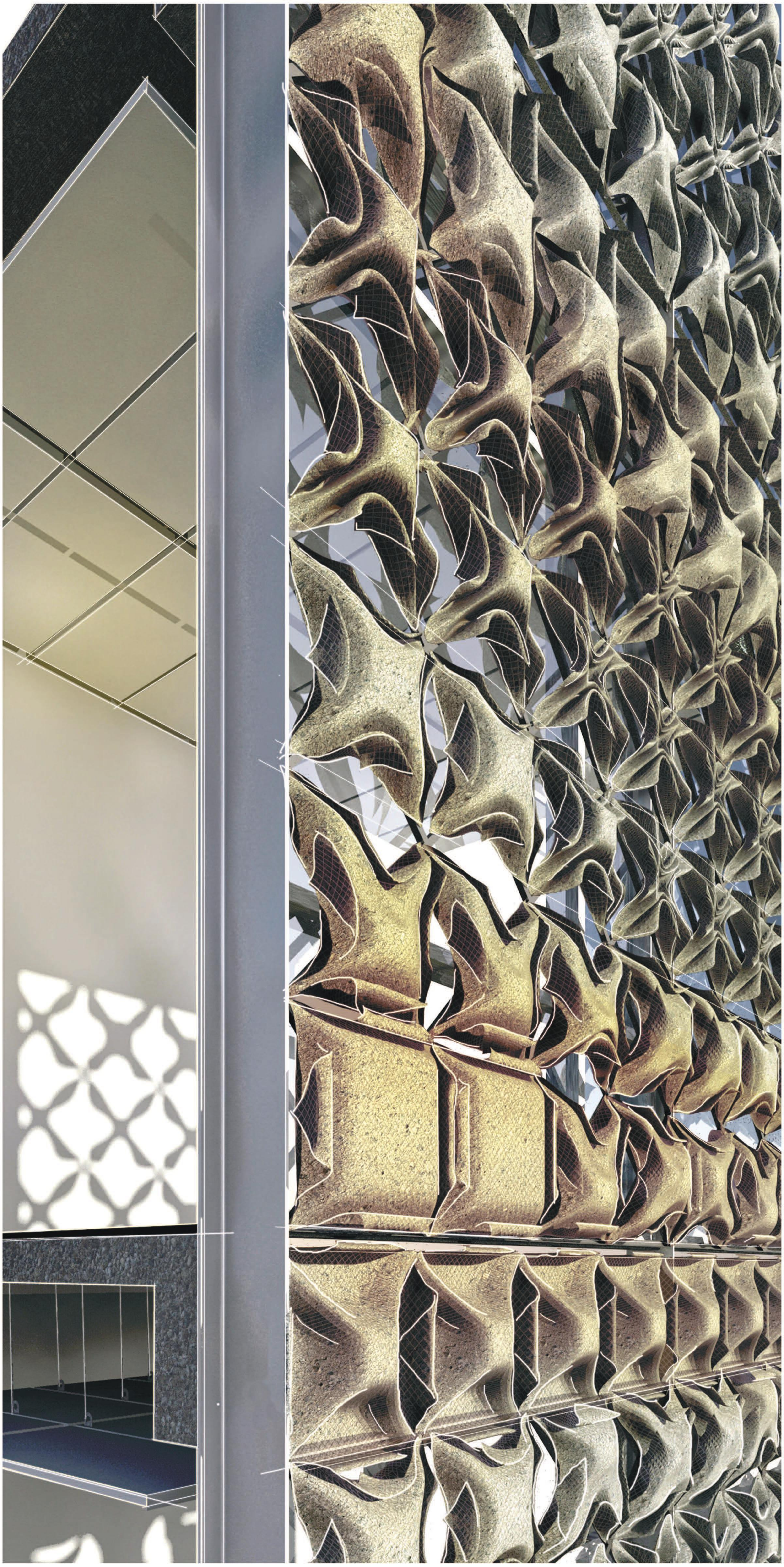


_MATERIALDATA

Concrete Canvas is a "flexible cement impregnated fabric that hardens on hydration to form a thin durable concrete layer." As a concrete, the material possesses an inherent strength, and as a fabric it has an innate organic quality and movement. The intrinsic life of the material stimulates a conscious awareness of the senses for an immediate response - modeling and molding the raw flesh-ness of the material from an idea, a thought or sketch.

This unique material property allows a range of surface manipulation, presenting potential for a dynamic cladding system that yields a complexity not available within current construction techniques.

_DURABLE

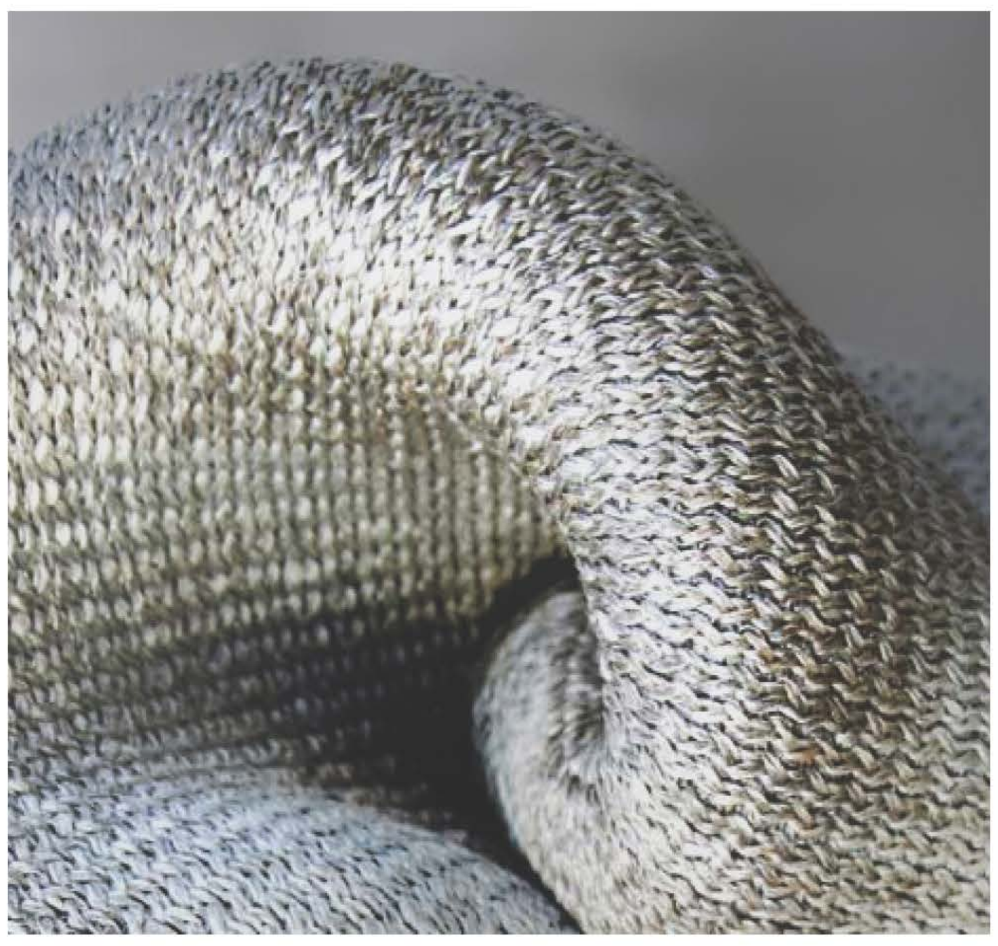
_FLEXIBLE

_STRONG

_RAPID

_FIREPROOF

_WATERPROOF



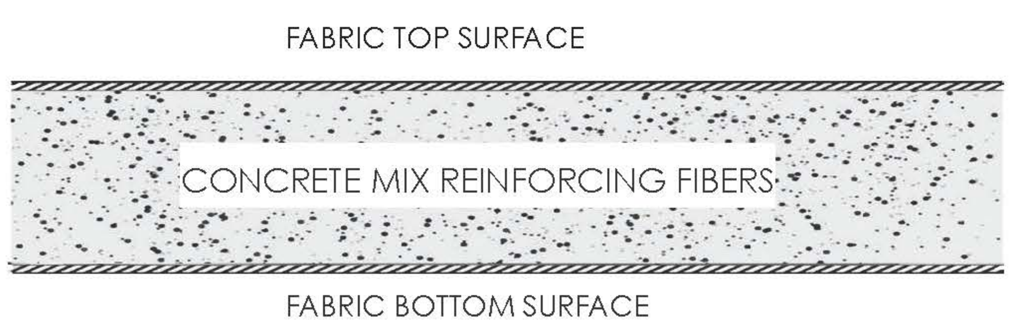
MATERIAL RESOURCES

Milliken & Company
Spartanburg,SC

Concrete Canvas
$4 - $11 sqft. + shipping

MILLIKEN®

CC SECTION VIEW



CONCRETE CANVAS DATA

CC	Thickness in	Roll Width ft	Weight Unset lb/sf	Batch Roll Length ft	Batch Roll Area sq	Batch Roll Weight Unset lbs	Bulk Roll Length ft	Bulk Roll Size sf	Bulk Roll Weight Unset lbs
CC5	.20	3.28	1.43	30	100	143	656	2153	3080
CC8	.31	3.61	2.46	15	55	135	373	1345	3300
CC13	.51	3.61	3.89	n/a	n/a	n/a	239	861	3345

DENSITY

_The dry density of Concrete Cloth before hydration is 93.6 pounds per cubic foot (1500 kg/m3). Upon complete hydration, the density increases 30-35% to a range of about 122-126 pounds per cubic foot (1950-2025 kg/m3).

STRENGTH

_Very high early strength is a fundamental characteristic of CC. Typical strengths and physical characteristics are as follows:

_Compressive testing based on ATSM C473 - 07

_10 day compressive failure stress (Psi) 5800

_10 day compressive Young's modulus (Psi) 217,600

_Bending tests based on BS EN 12467:2004

_10 day bending failure stress (Psi) 493

_10 day bending Young's modulus (Psi) 26,100

_Abrasion resistance (DIN 52108)

_Similar to wear resistant ceramic Max 0.10 gm/cm2

_CBR Puncture Resistance EN ISO 12236: 2007 (CC8 & CC13 only)

_Min. Push-through force 605 lb/f

_Max. Deflection at Peak 1.5"

SETTTING

_Initial Set ~ 120 min.

_Final Set ≥ 240 min.

_CC will achieve 70-80% strength at 24 hours after hydration.

_Method of hydration

_Spray the fiber surface multiple times until the CC is saturated. The wet CC will first darken and then become lighter as it absorbs the water. CC is saturated when water pool on the surface or runs off. See the hydration guide for more information.

OTHER

_Freeze-thaw testing (BS EN 12467:2004 part 5.5.2) Passed

_Soak-Dry testing (BS EN 12467:2004 part 5.5.5) Passed

_Water impermeability (BS EN 12467:2004 part 5.4.4) Passed

_Moisture vapor transmission rate

_PVC Thickness 0.017"

_PVC MVTR range 0.836 - 0.924 g.mm/(m2.day)

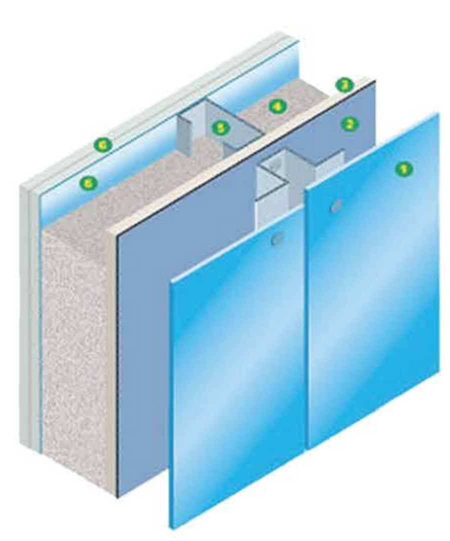
_DESIGNRESEARCHPROBLEM

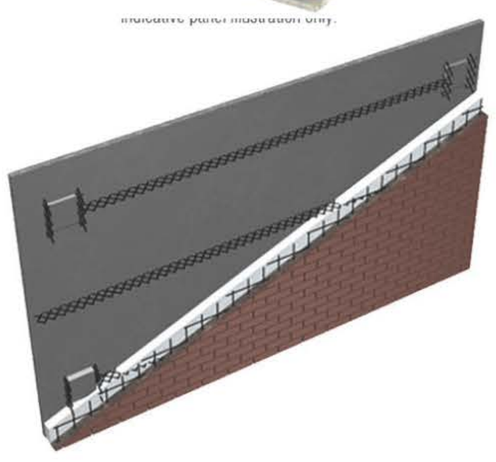
Precast Panels are a common type of building cladding that makes use of prefabricated construction. Any precast approach that intents to create unique panels will still have cost and sustainability impacts that could limit the customization that could be achieved.

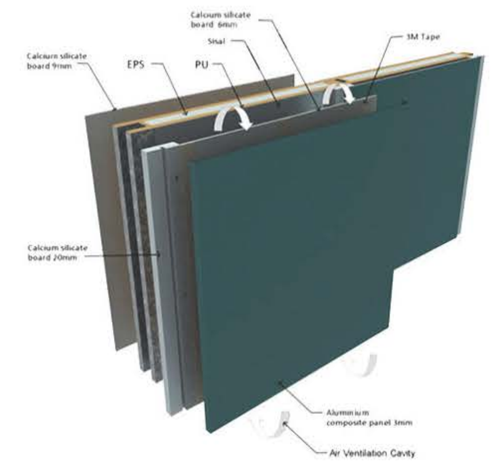
The project will explore the hybridized fabric/concrete material properties of Canvas Concrete through surface manipulation techniques to create an external cladding system.

TYPICAL CLADDING SYSTEMS

Current construction techniques within prefabricated cladding systems are limited to a sandwiching of layers to acheive a standard of thermal performance. In the case of glazing, a secondary independant system is usually necessary for any kind of solar shading. This composite cladding system can be considered very rudementary and has opportunity for improvement.







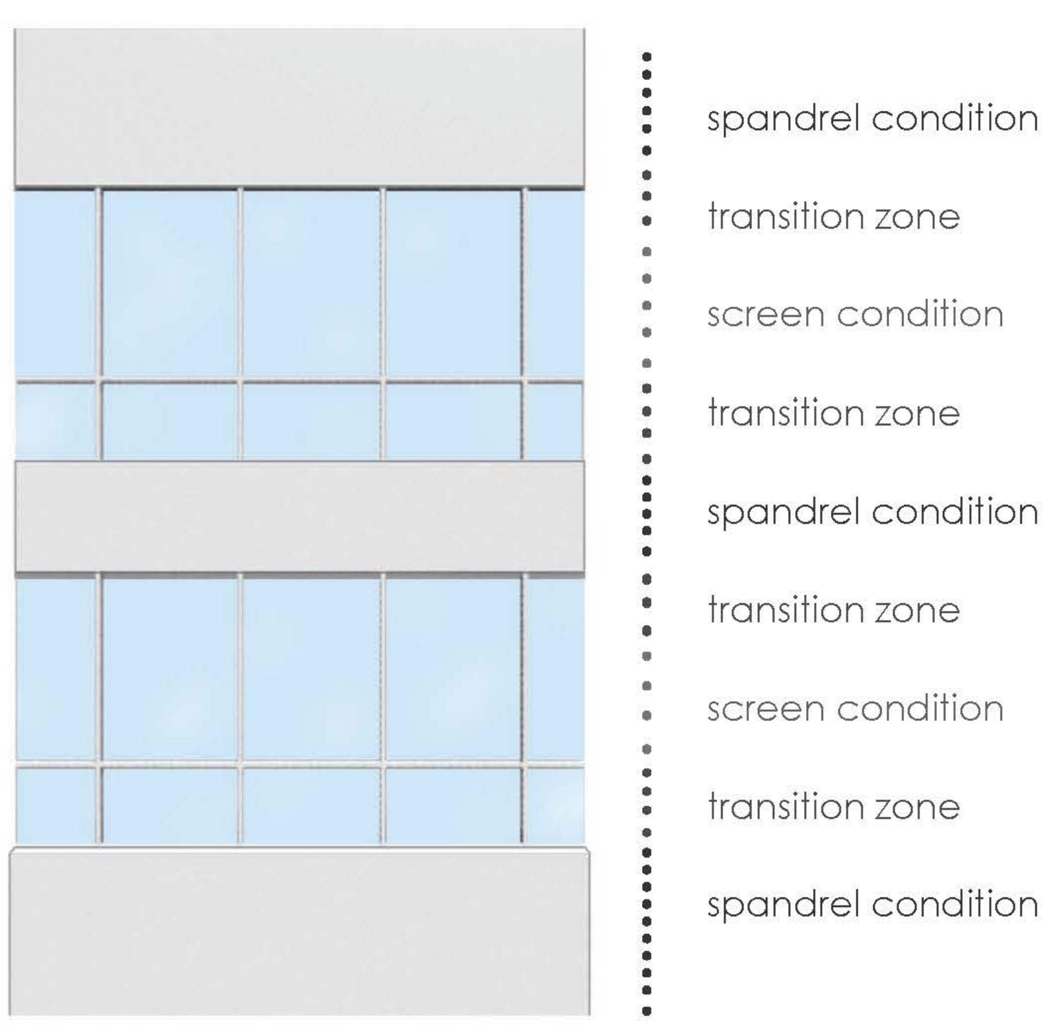
APPLICATION

As a secondary façade system/rainscreen cladding that parametrically responds to solar/ lighting and programmatic requirements.

variability of the unit module allows for aggregation that provides varying degree of opacity ranging from dense spandral to less dense screen

New materials, new tools, and new methods could revolutionize the aesthetic of architectural panels allowing for mass customization of projects.

- -Form
- -Fit
- -Function
- -Unified
- -Simplicity
- -Affordability



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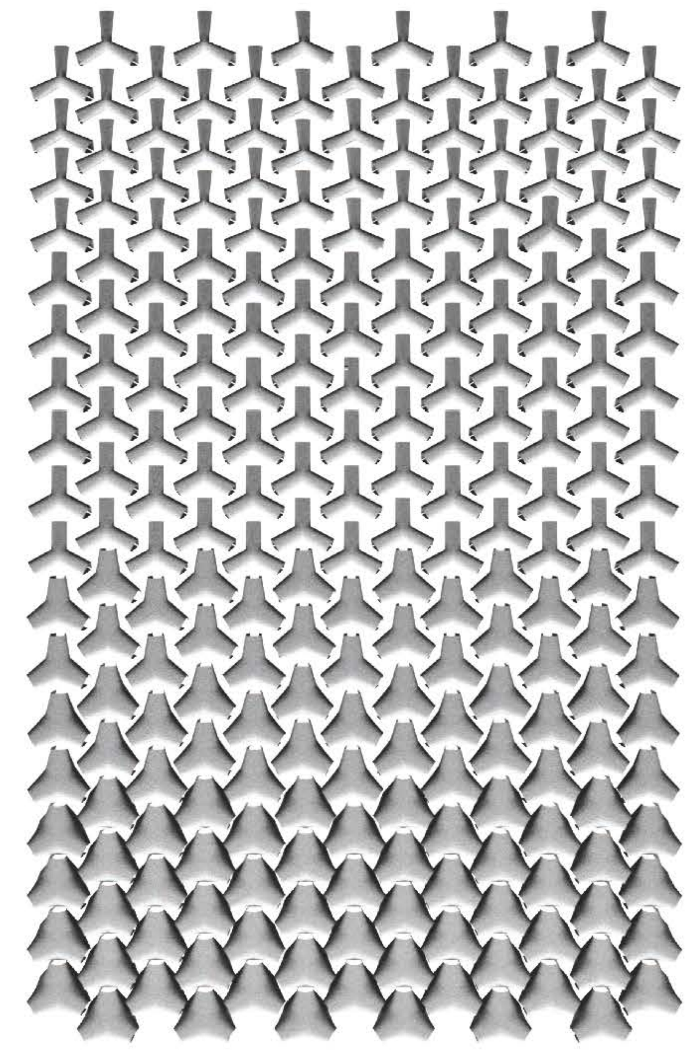

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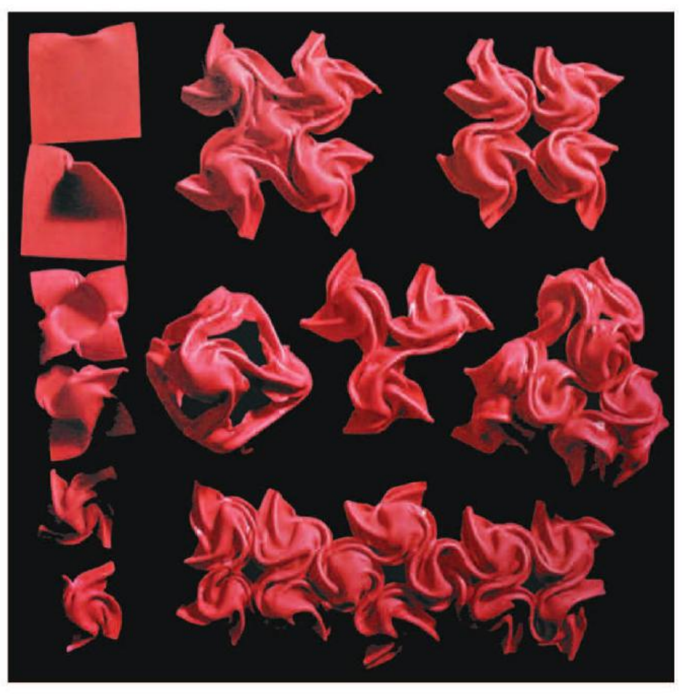
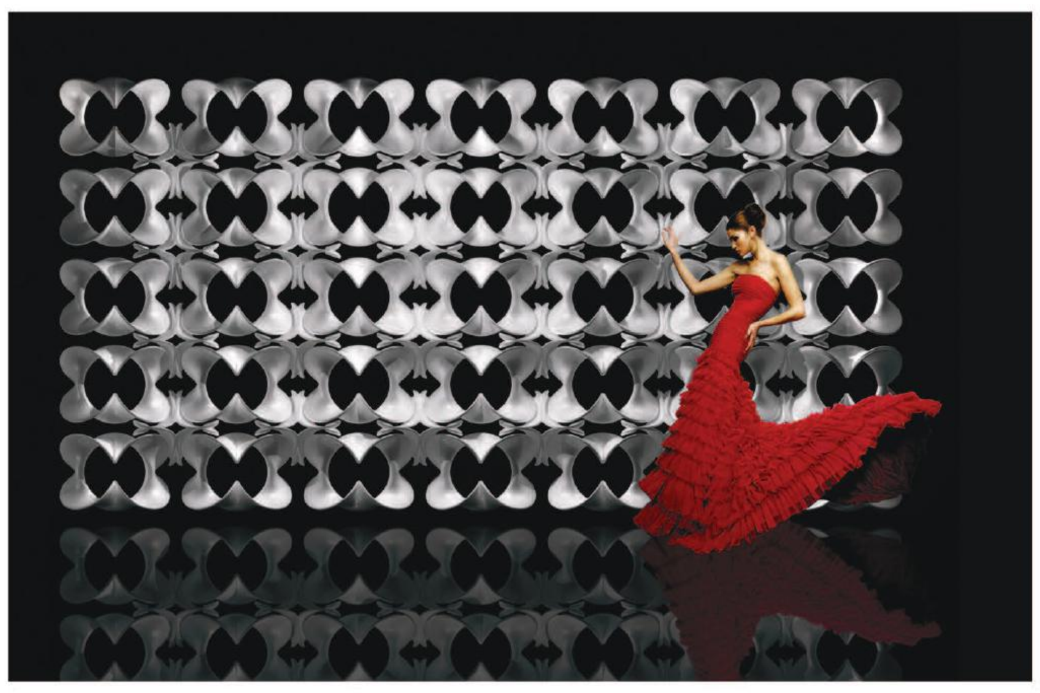
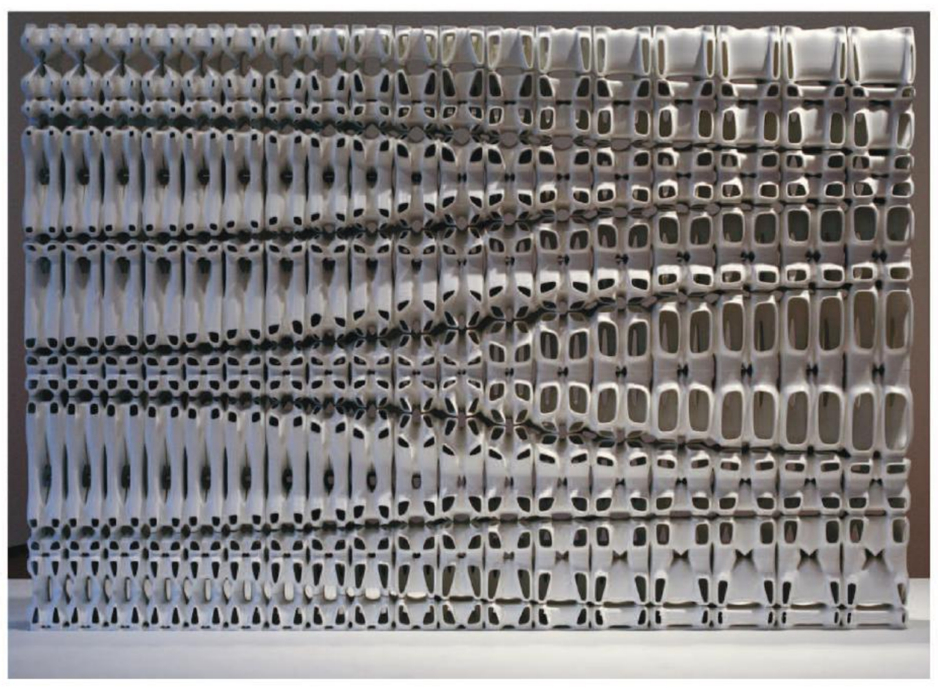
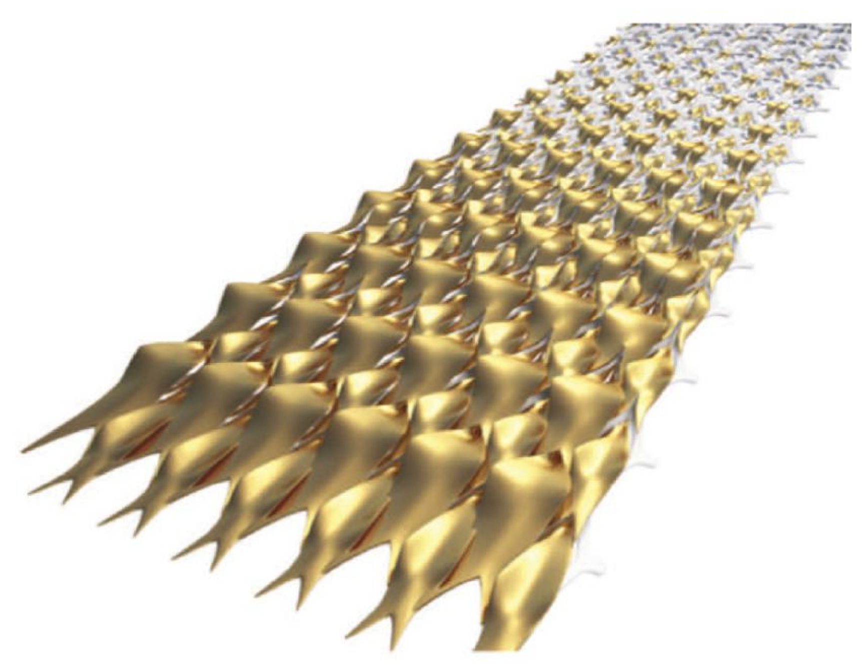
_CASE STUDIES









EVAN DOUGLIS

Autogenic Structures

Douglis' projects offer an alternative vision for the future of architecture, a timely and invaluable contribution to the debate concerning emergent surfaces and the next generation of building membranes in the era of extreme computational control. Douglis presents topics such as the relationship between structure and ornamentation, the value of mass customization in the next generation of modular building components, and the role of smart materials in creating a sustainable future.

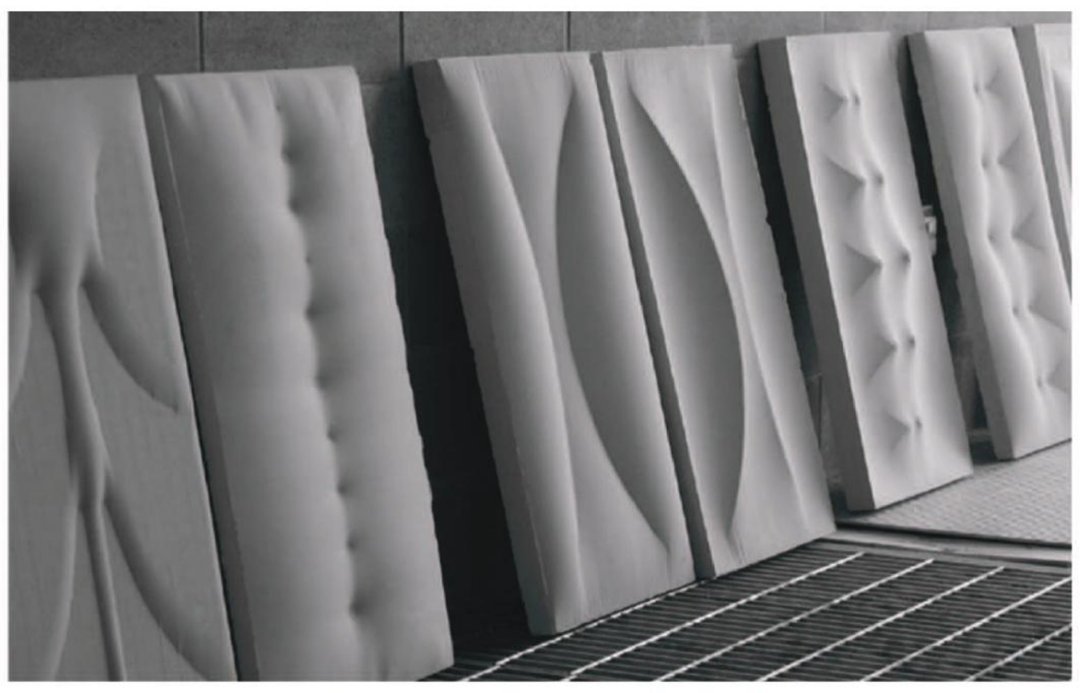
ALI RAHIM

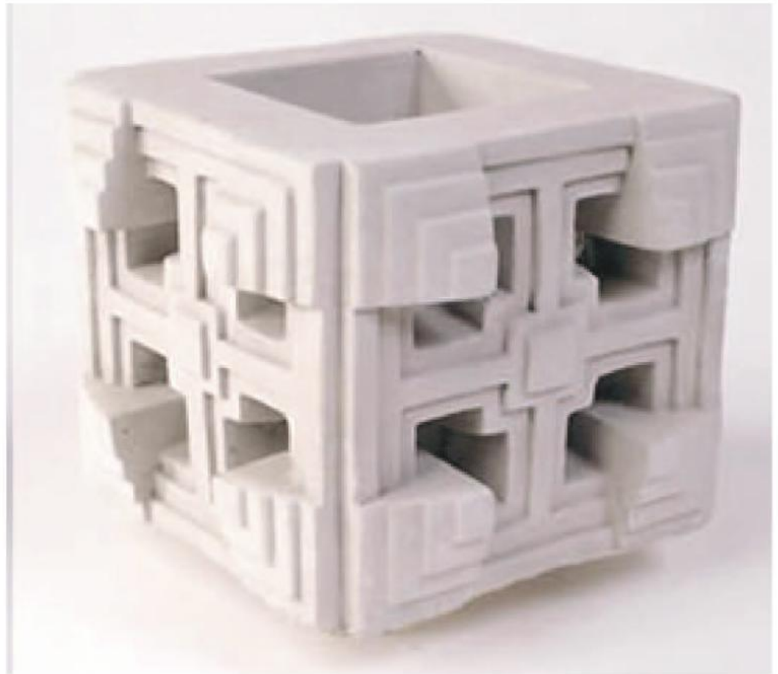
Ali Rahim emphasises the importance for design of overlaying a mastery of digital techniques with a nuanced and developed aesthetic sensibility. Here he illustrates his fascination with the formal with his exploration of 'interiorities', or internal logics of tectonic structures, in his design research at the University of Pennsylvania. The strive to create variation and atmosphere in buildings effectively places a stress on different part-to-whole relationships, organisations, material qualities and colours and their various rates of transformation.

MARK GAGE

_Kaohsiung Pop Center project, Gage / Clemenceau Architects developed a rain-screen system that allowed for gradient transitions between metallic gold reflective areas into Aalborg white concrete surfaces.

_By dividing the rain screens into interlocking tiles, the gradients could be customized to meet the requirements of any building and modulate lighting, solar gain, reflectivity, and color into a single system of applied parts.





MARK WEST

Fabric-Formed Precast Panels

Simple, Economical Formwork For Natural Forms and Structural Efficiency

Severl methods of using flexible flat-sheet membranes (ex. woven polyolefin geotexiles) as formwork for precast concrete panels. The use of a simple flat sheet of fabric that is allowed to deflect naturally under its load as formwork produces spontaneously formed, double curvature, tension geometries that are both extraordinarily beautiful and structurally elegant. The simplicity of the method, and the very low cast of the fabrics used make these techniques globally acessible to both high- and low-capital building economies.

FRANK LLOYD WRIGHT

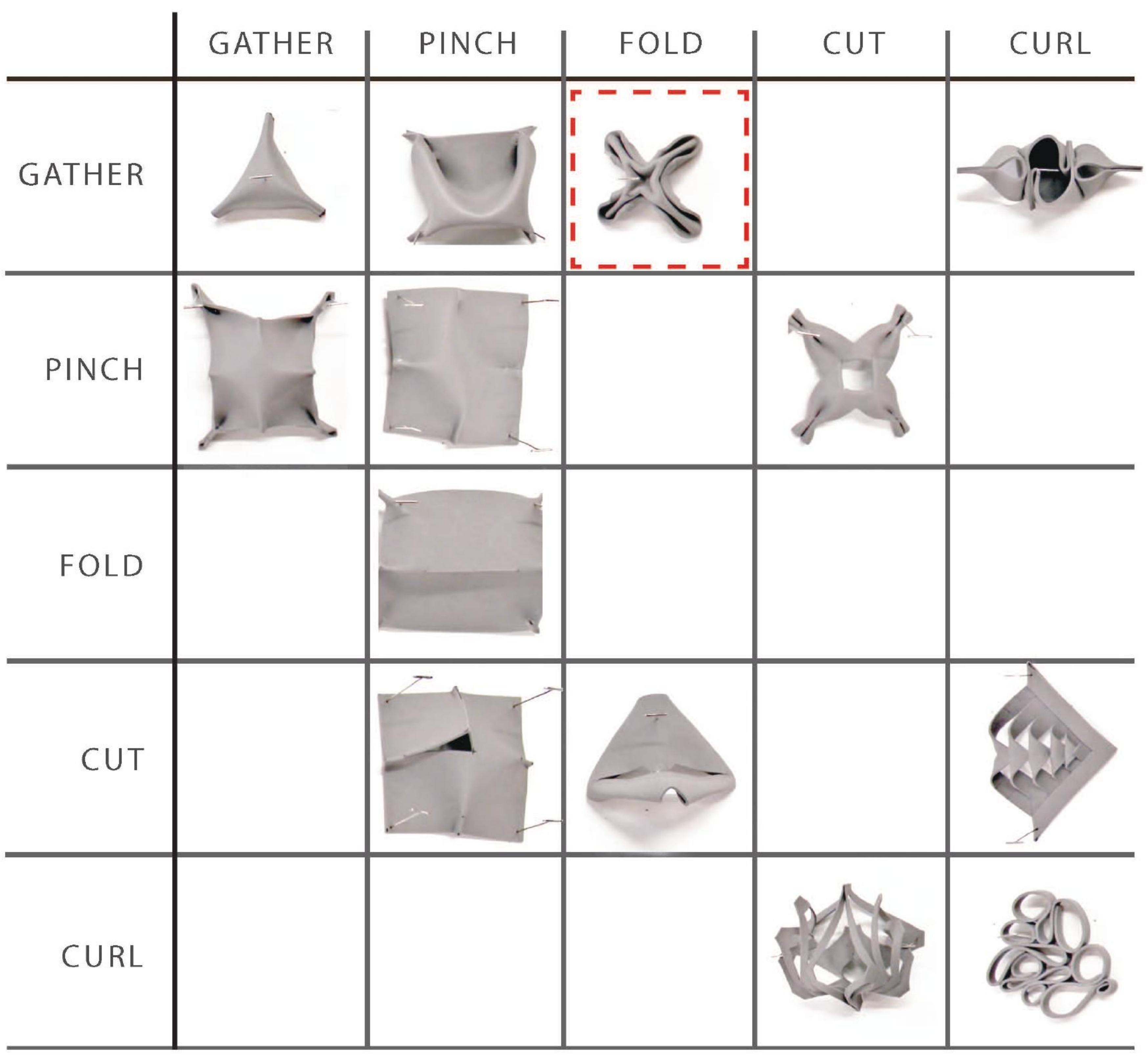
The textile block system is a unique structural system created by Frank Lloyd Wright in the early 1920s. Individual concrete blocks are precast patterned and reinforced with steel. An early example of prefabricated building components, the blocks are shipped to the site where they are assembled. These blocks were developed with variations allowing for introduction of natural light, which can be seen as a predecessor for current explorations in parametric design.

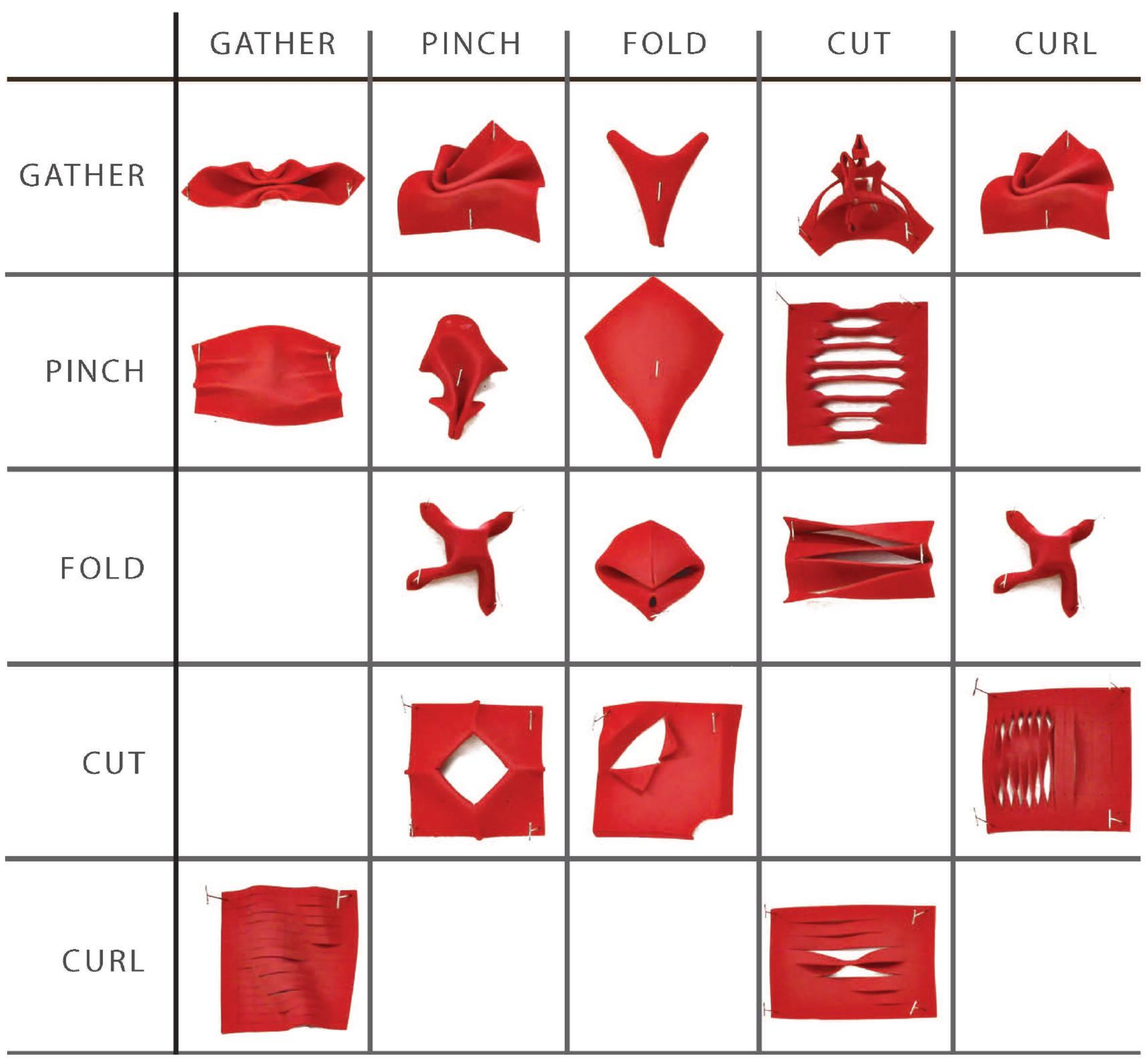
_MANIPULATION TECHNIQUES

A defined set of operative techniques allow for controlled and systematic exploration of the capabilities and limitations of Concrete Canvas in the design of a unit module that ultimately must fulfill facade performance criteria. Through a matrix of modeling iterations, geometric outcomes inform the process and lead to a refined aesthetic sensibility.

GEOMETRIC OUTCOMES	PRIORITY	FACADE PERFORMANCE REQUIREMENTS	PRIORITY
VOLUME	● ●	SOLAR MITIGATION	● ● ● ● ●
TEXTURE	● ● ●	MODULARITY	● ● ● ●
RIGIDITY	● ● ● ●	VARIABILITY	● ● ● ●
APERTURE	● ● ● ● ●	RAIN WATER RUN-OFF	● ● ●
STRIATION	●		

OPERATIVE MATRIX





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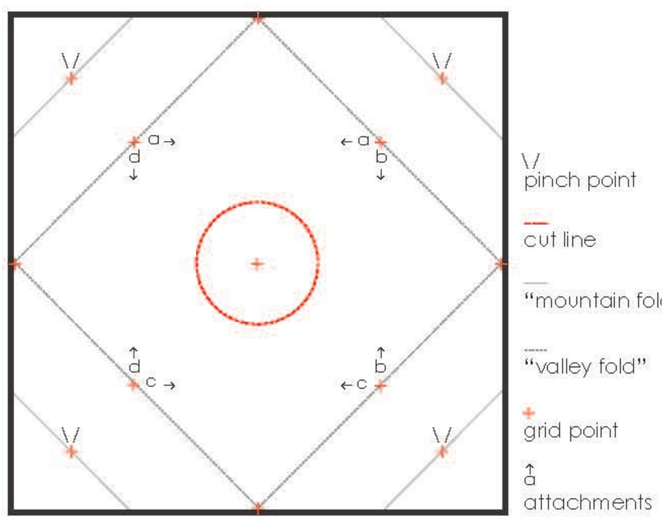
_ FABRICATION **PROCESS**

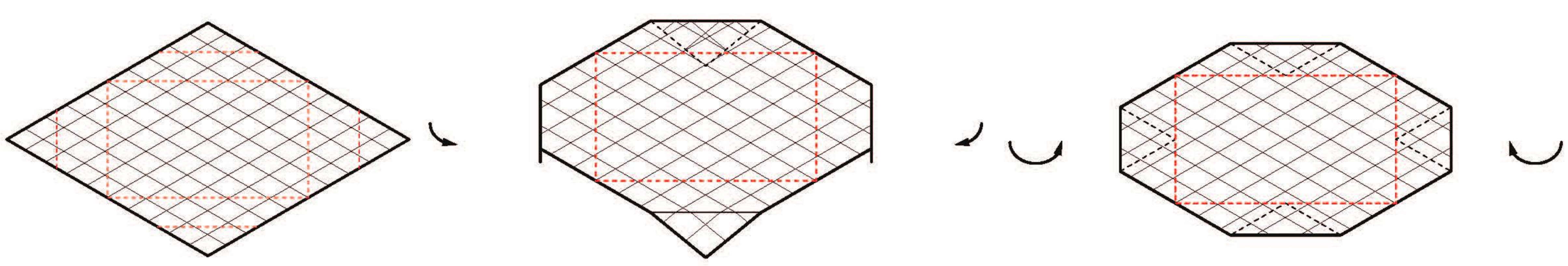
Once the matrix was organized around an established language of operatives, these were translated into methodology for strategically fabricating the modules. An existing example of this kind of process is found in origami. A set dialogue of "mountains", "valleys", and "cuts" informs the user and acts as a control , ensuring that each module is replicated identically.

Using a similar language to origami, the operative moves established within the matrix are translated onto the preliminary panel to ensure that each end product is identical.



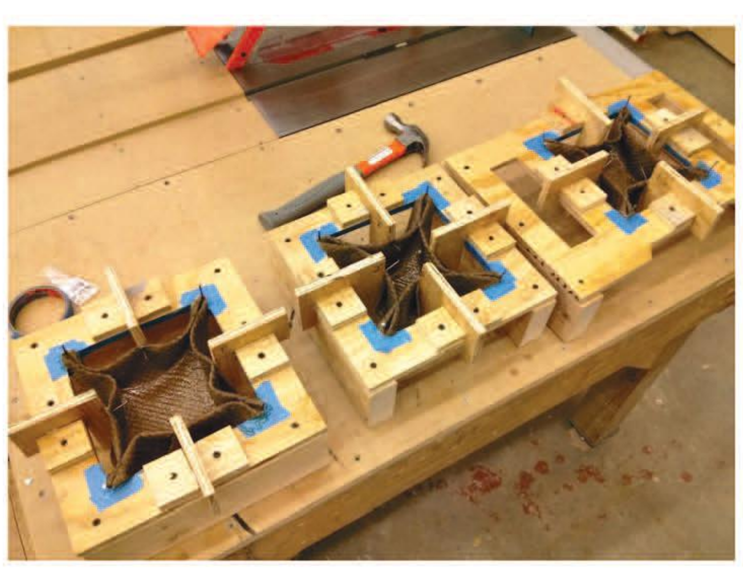
an example of the systemized execution of operatives based on origami diagrams

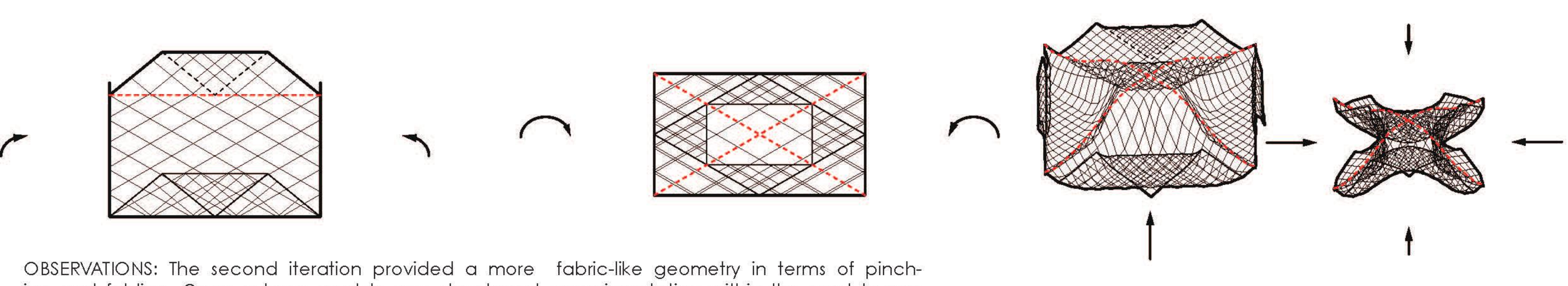
MODULE 01:



OBSERVATIONS: While the triangular module provides an efficiently modular system while providing variability for transparency, the outcome could be similarly cast in concrete with a mold, which does not push the limits of the materiality or take advatage of its fabric nature.

MODULE 02:





OBSERVATIONS: The second iteration provided a more fabric-like geometry in terms of pinching and folding. Once a base module was developed, experimentation within the module was done to provide variation and to further explore performative possibilities. Keeping the 4 corners constant, the sides were pushed independently to give variability and flexibility to adapt to local conditions and provide varying degrees of transparency. Furthermore, steps were taken to introduce sectional angularity allowing for more specific viewing /shading conditions. s

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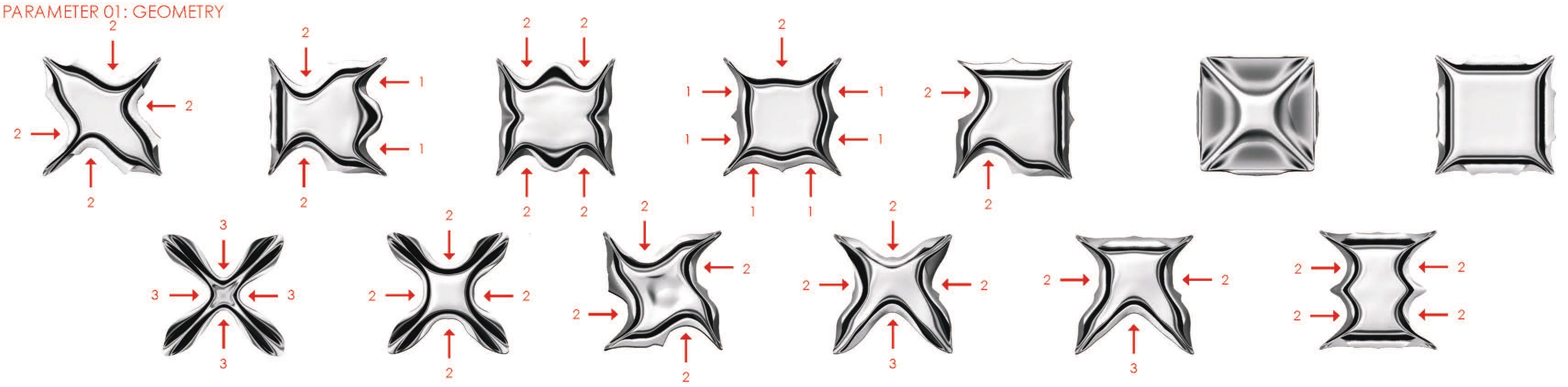
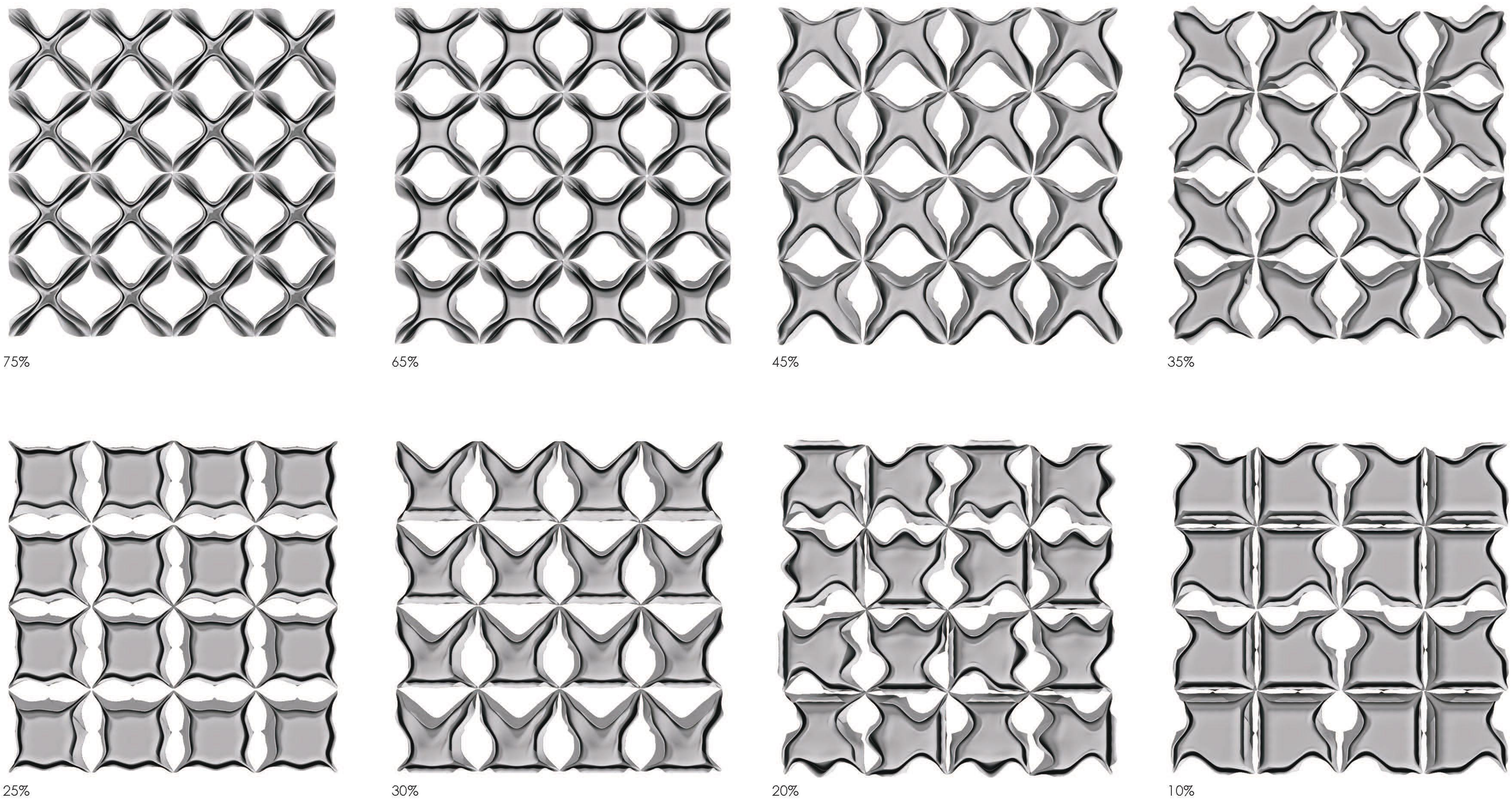
_PARAMETRIC**INFLUENCE**

PARAMETER 01: GEOMETRY

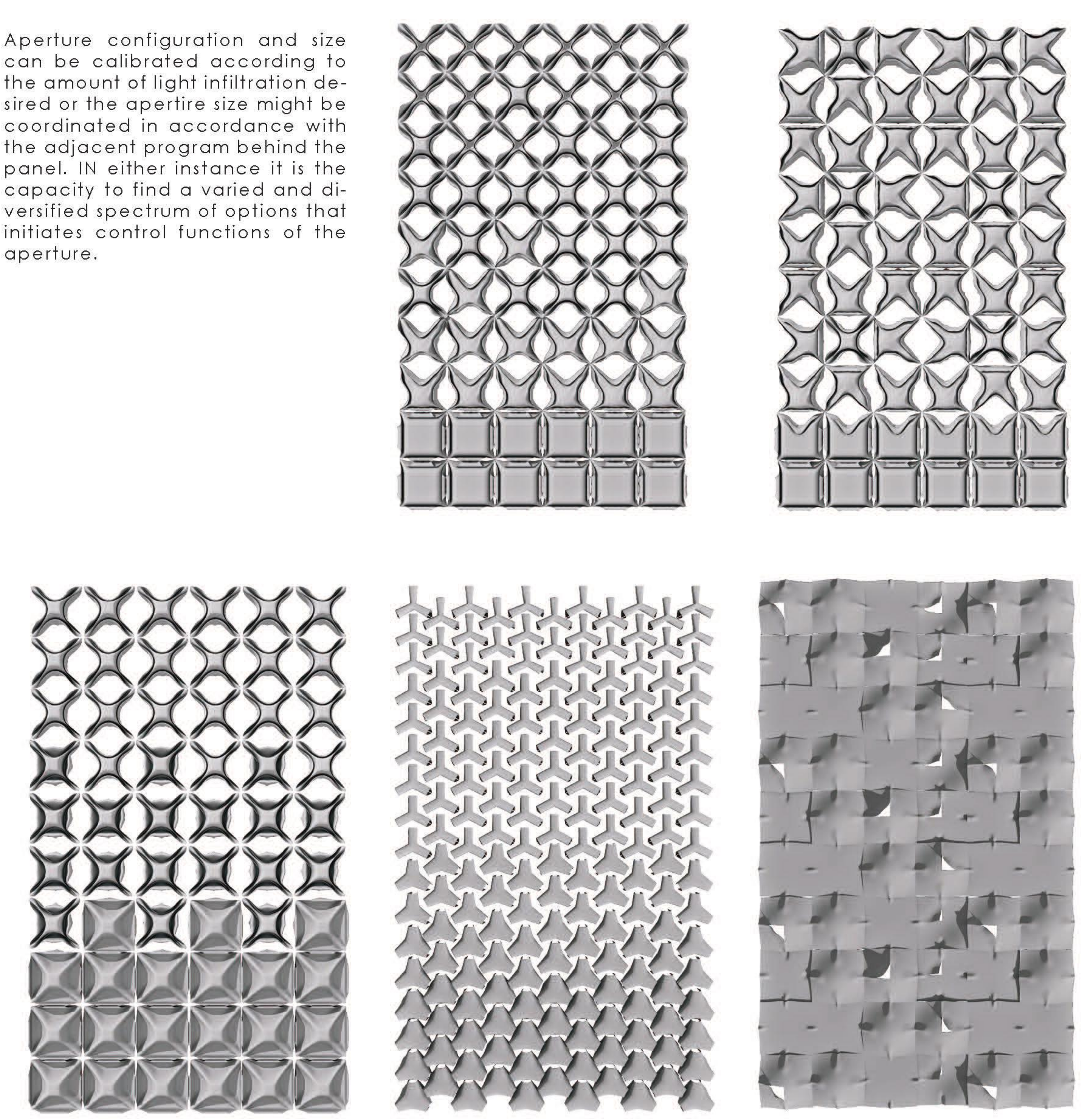


PARAMETER 02: DENSITY

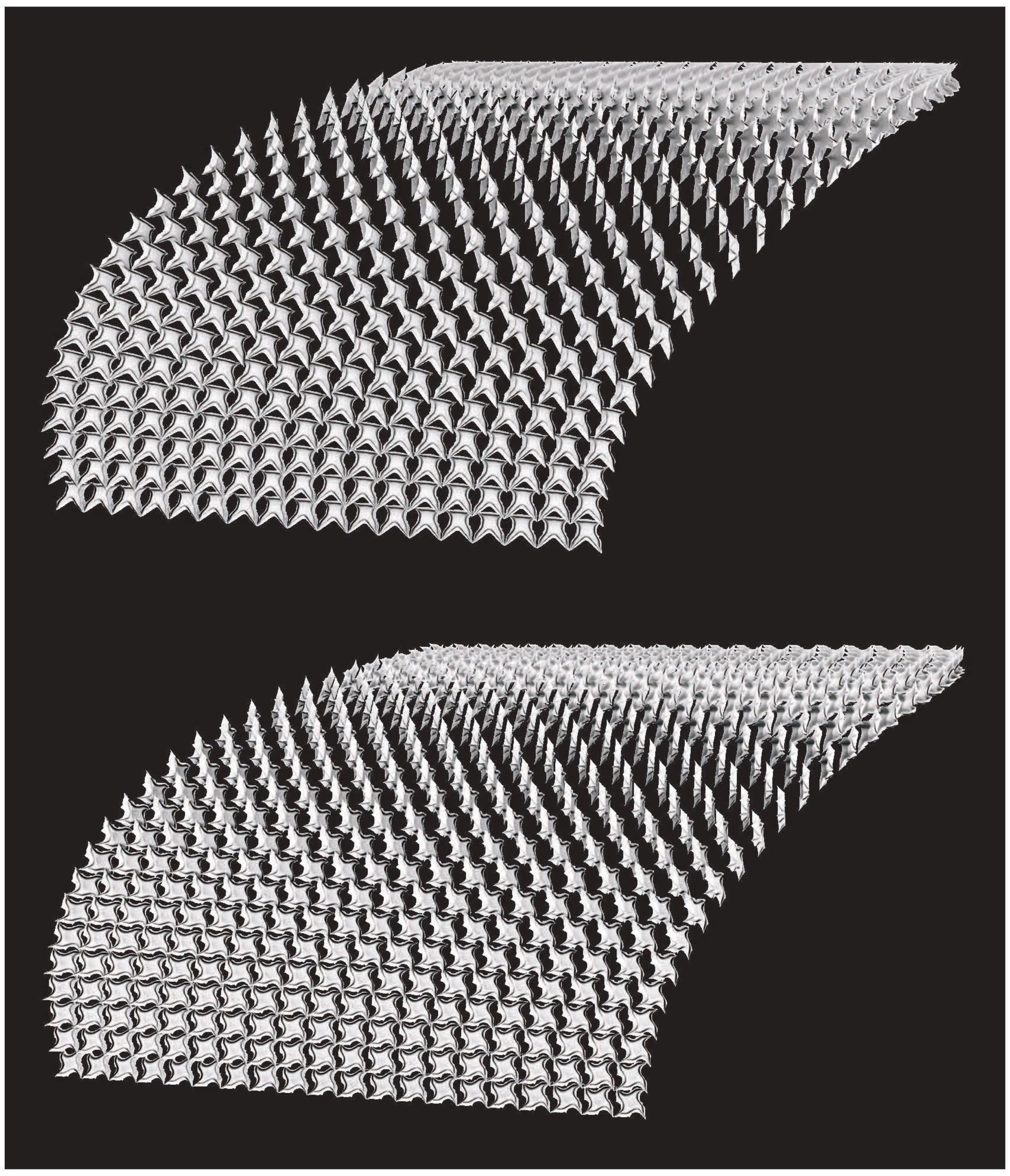


PANEL DISTRIBUTION

Aperture configuration and size can be calibrated according to the amount of light infiltration desired or the apertire size might be coordinated in accordance with the adjacent program behind the panel. IN either instance it is the capacity to find a varied and diversified spectrum of options that initiates control functions of the aperture.



VARIATIONS



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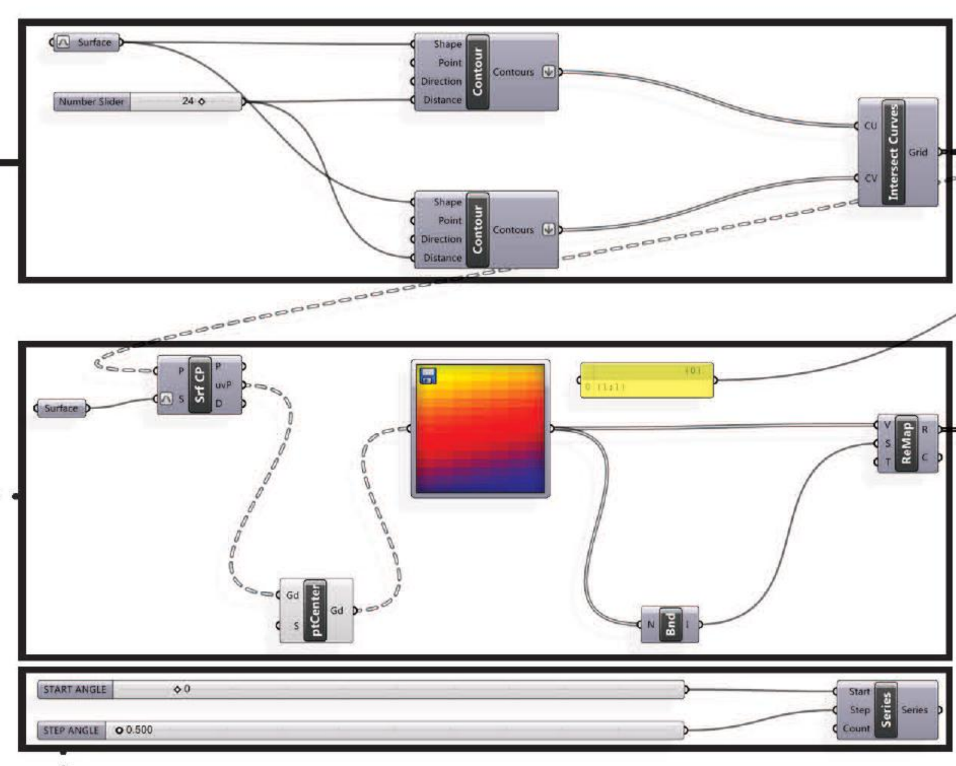
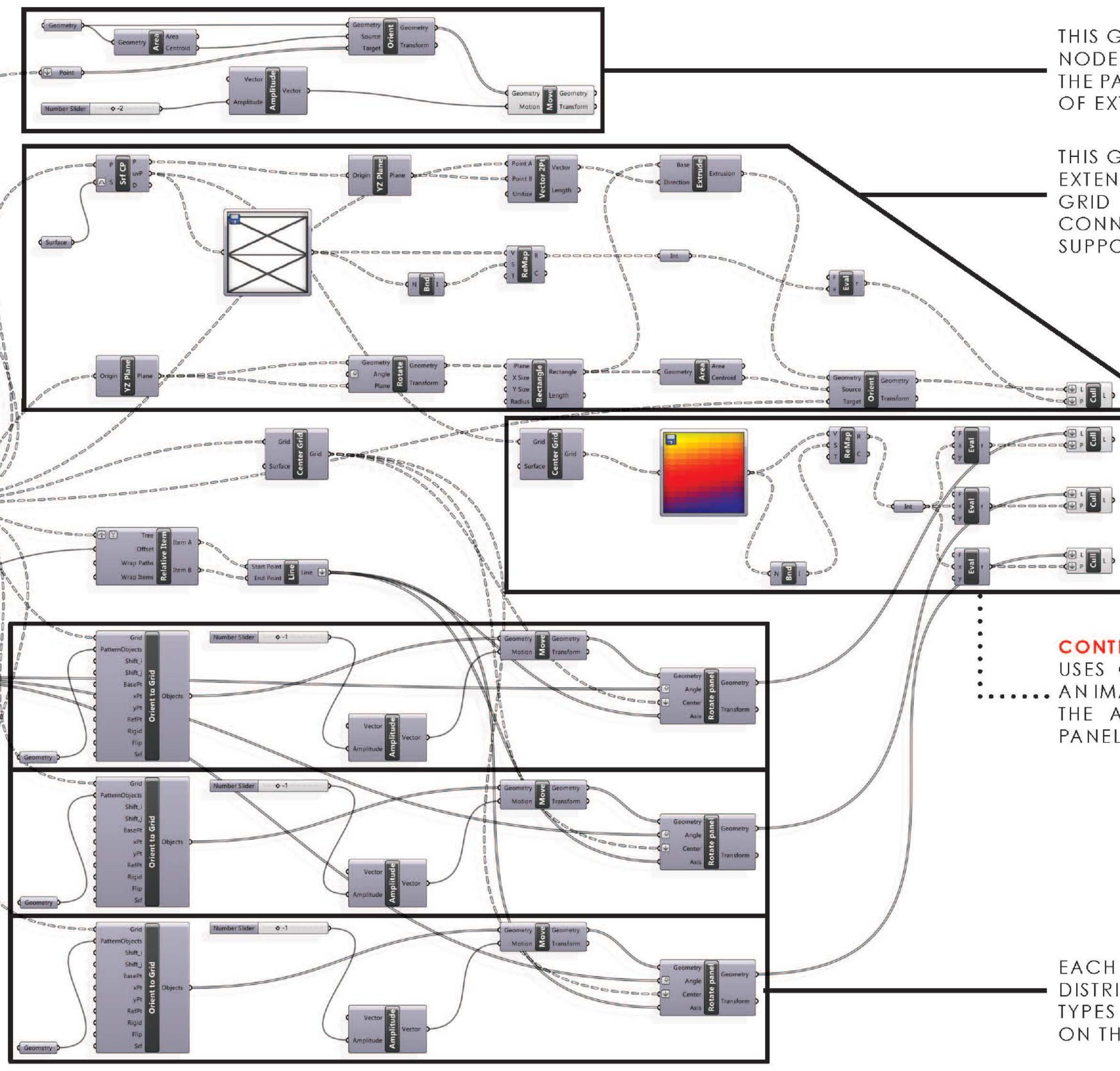
_PARAMETRIC **CONTROL**

THE UTILIZATION OF PARAMETRIC CONTROLS WITHIN THE SCOPE OF THIS PROJECT ARE SUCH TO CONDUCT AN ANALYSIS WITH THE GOAL OF OPTIMIZING THE ANNUAL ENERGY CONSUMED BY 2 ROOMS, ALONG A SOUTH FACING FAÇADE, IN DALLAS/FORT WORTH.

OPTIMIZATION OF THE HVAC SYSTEM LOADS IS ACHIEVED BY MINIMIZATION OF DIRECT SOLAR/THERMAL GAIN THROUGH THE CURTAIN WALL SYSTEM BY PARAMETRIC SELECTION, DISTRIBUTION AND ROTATON OF THREE CONCRETE PANEL TYPES RESPECTIVELY.

THIS GROUP OF ELEMENTS ESTABLISHES A POINT-GRID AT A SPECIFIED DISTANCE BETWEEN ONE ANOTHER, ON ANY SURFACE





THIS GROUP OF ELEMENTS DISTRIBUTES NODES AT ASSIGNED GRID POINTS FOR THE PANELS TO ATTACH TO A NETWORK OF EXTENSION POSTS

THIS GROUP OF ELEMENTS DISTRIBUTES EXTENSION POSTS AT ASSIGNED GRID POINTS TO ATTACH THE NODE CONNECTIONS TO THE TENSION ROD SUPPORT SYSTEM

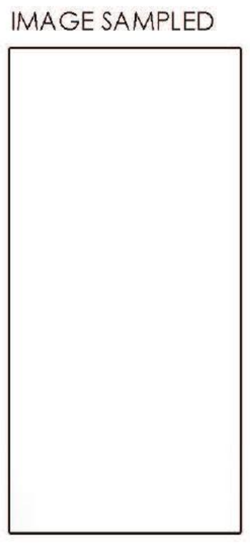
CONTROL 1 THIS GROUP OF ELEMENTS USES COLOR VALUES DERIVED FROM AN IMAGE TO ESTABLISH A PATTERN FOR THE ARRANGEMENT THE RESPECTIVE PANEL TYPES

ALTERNATE CONTROL 2 THIS GROUP OF ELEMENTS INCREMENTALLY ROTATES SEQUENTIAL PANELS

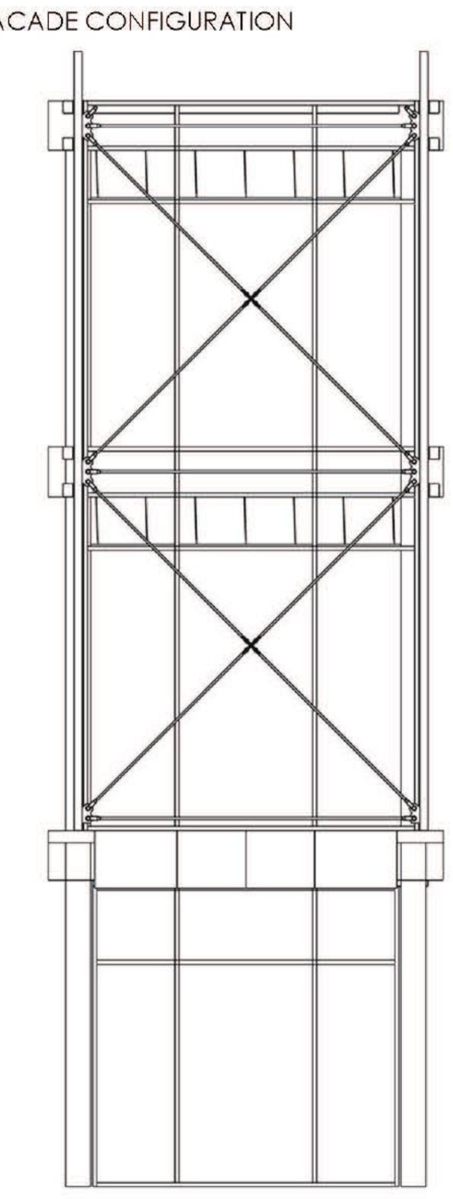
CONTROL 2 THIS GROUP OF ELEMENTS USES COLOR VALUES DERIVED FROM AN IMAGE TO ESTABLISH A PATTERN FOR THE ROTATION OF INDIVIDUAL PANELS, BETWEEN A SPECIFIED ANGULAR RANGE

EACH OF THESE GROUPS OF ELEMENTS DISTRIBUTES A THE RESPECTIVE PANEL TYPES ON THE POINT GRID LOCATED ON THE ASIGNED SURFACE

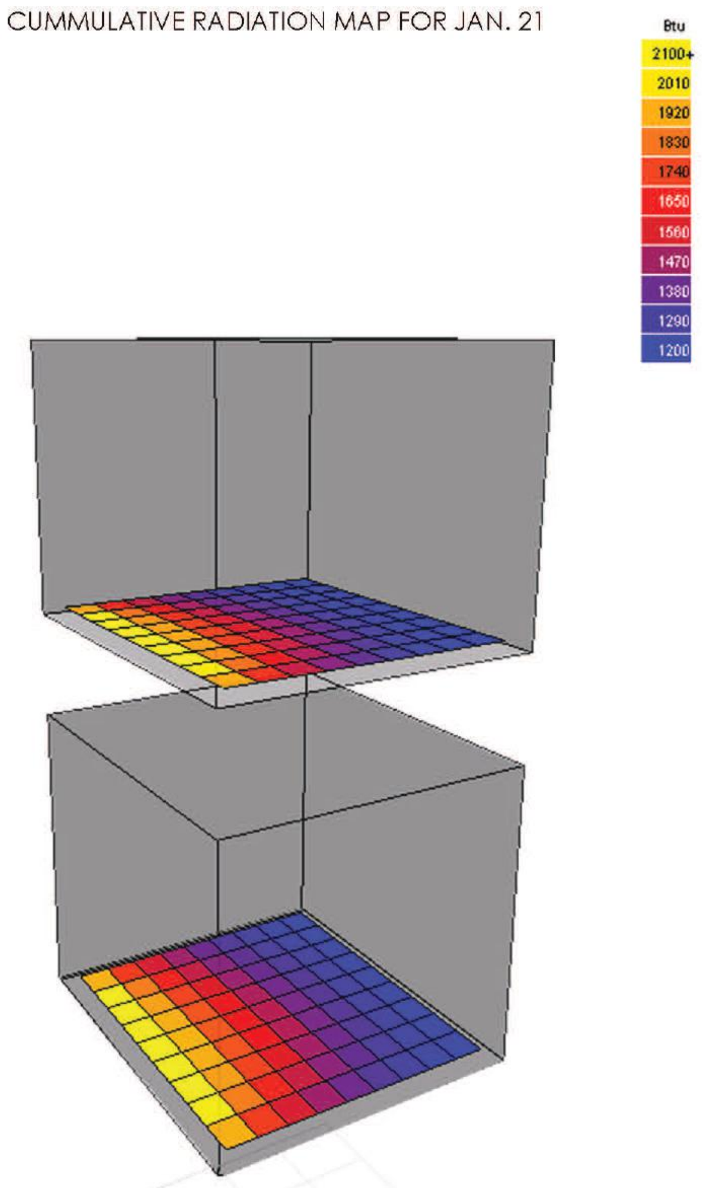
IMAGE SAMPLED



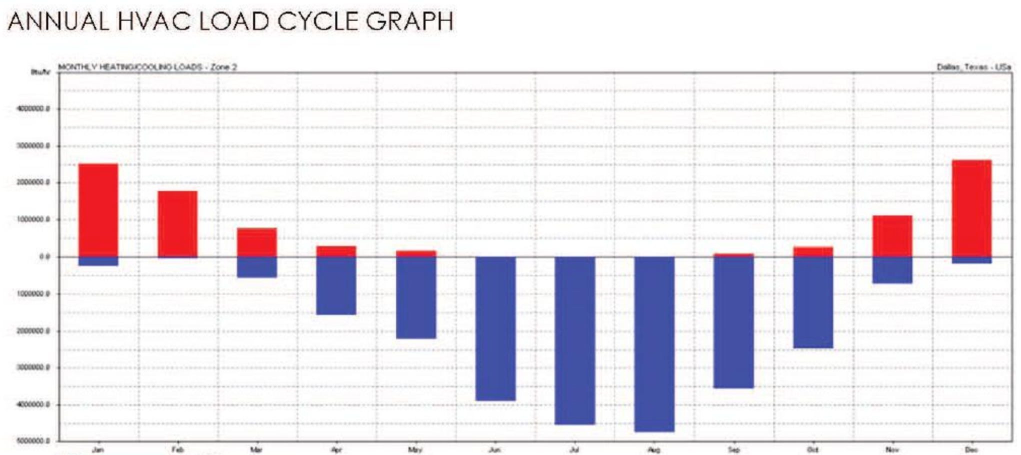
FACADE CONFIGURATION



CUMMULATIVE RADIATION MAP FOR JAN. 21



ANNUAL HVAC LOAD CYCLE GRAPH



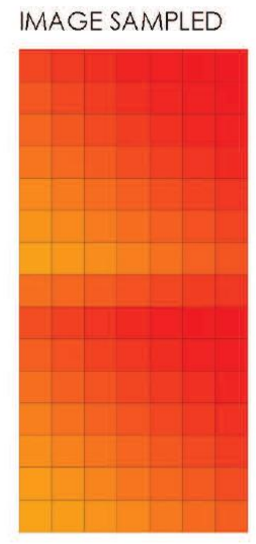
ANNUAL HVAC LOAD CYCLE GRAPH

Zone: Zone 2
Operation: Weekdays 08-19, Weekends 00-24.
Thermostat Settings: 70.0 - 75.0 F

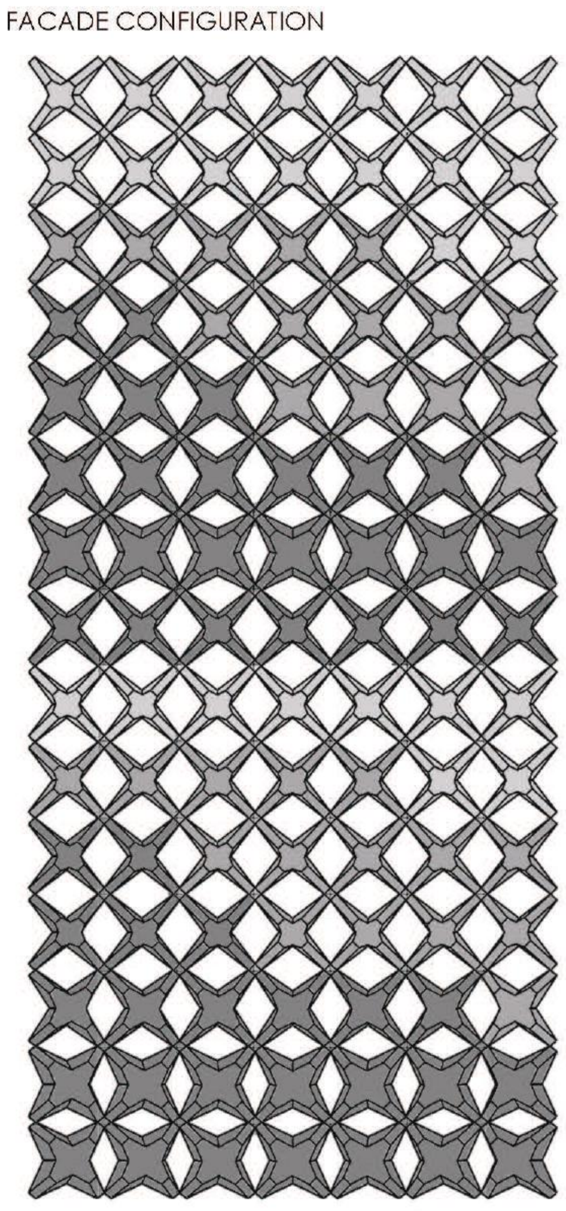
Max Heating: 17967.9 Btu/hr at 07:00 on 28th January
Max Cooling: 22059.2 Btu/hr at 13:00 on 19th November

		HEATING	COOLING	TOTAL
MONTH		(Btu)	(Btu)	(Btu)
TOTAL		9509240	24714958	34224200
PER M²		317261	824575	1141836
Floor Area:	322.63 ft2			

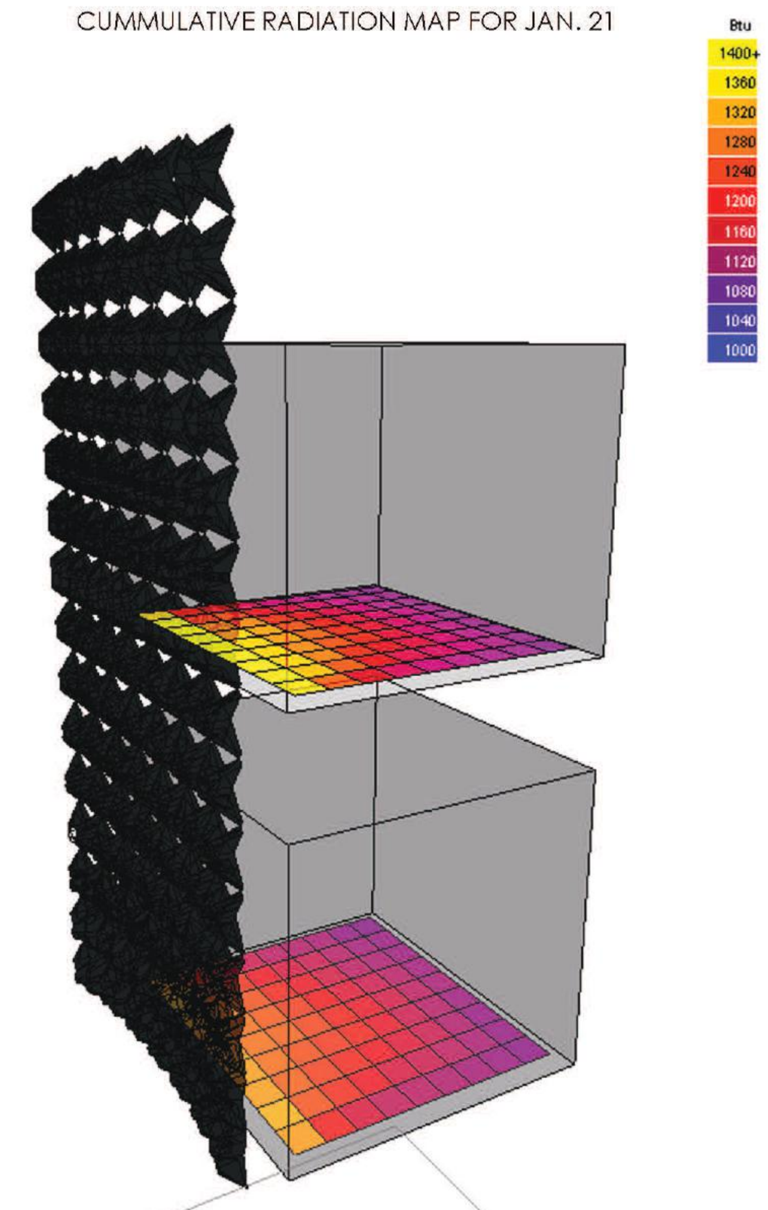
IMAGE SAMPLED



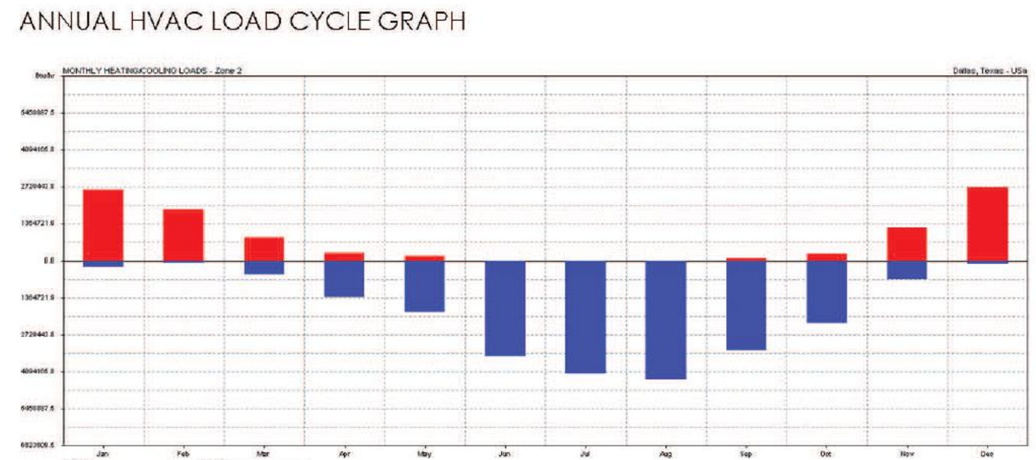
FACADE CONFIGURATION



CUMMULATIVE RADIATION MAP FOR JAN. 21



ANNUAL HVAC LOAD CYCLE GRAPH



ANNUAL HVAC LOAD CYCLE GRAPH

001_NO ROTATION_HVAC LOADS

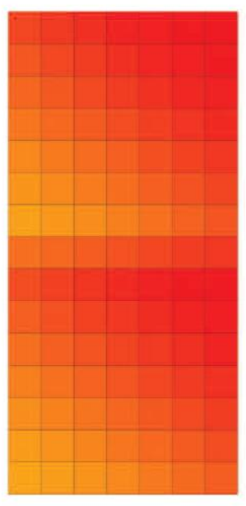
Zone: Zone 2
Operation: Weekdays 08-19, Weekends 00-24.
Thermostat Settings: 70.0 - 75.0 F

Max Heating: 17967.9 Btu/hr at 07:00 on 28th January
Max Cooling: 22059.2 Btu/hr at 13:00 on 19th November

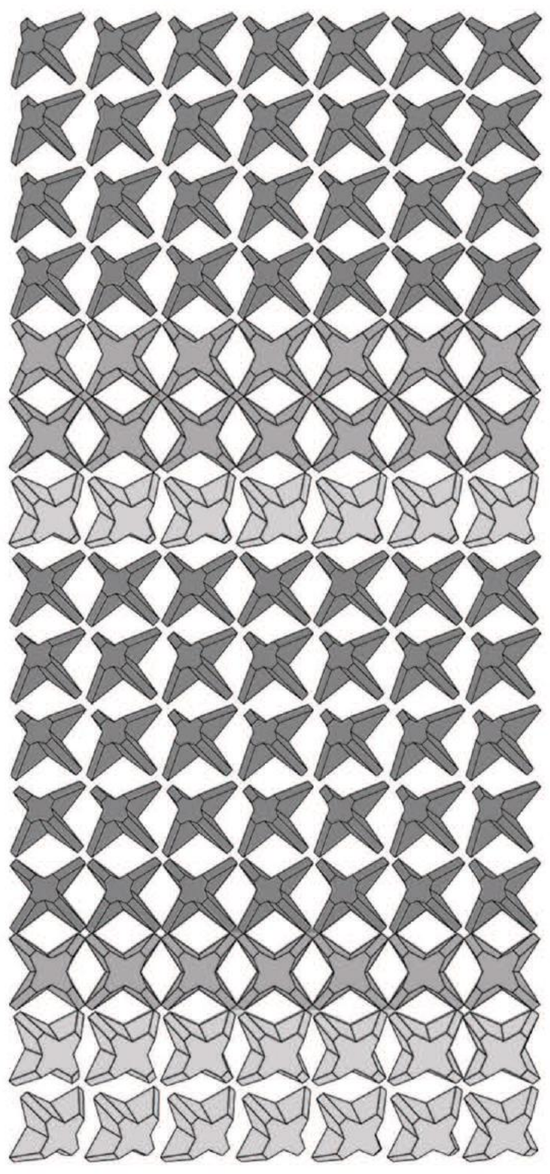
		HEATING	COOLING	TOTAL
MONTH		(Btu)	(Btu)	(Btu)
TOTAL		10092031	22269200	32361230
PER M²		336704	742976	1079681
Floor Area:				

_PERFORMATIVE**ANALYSIS**

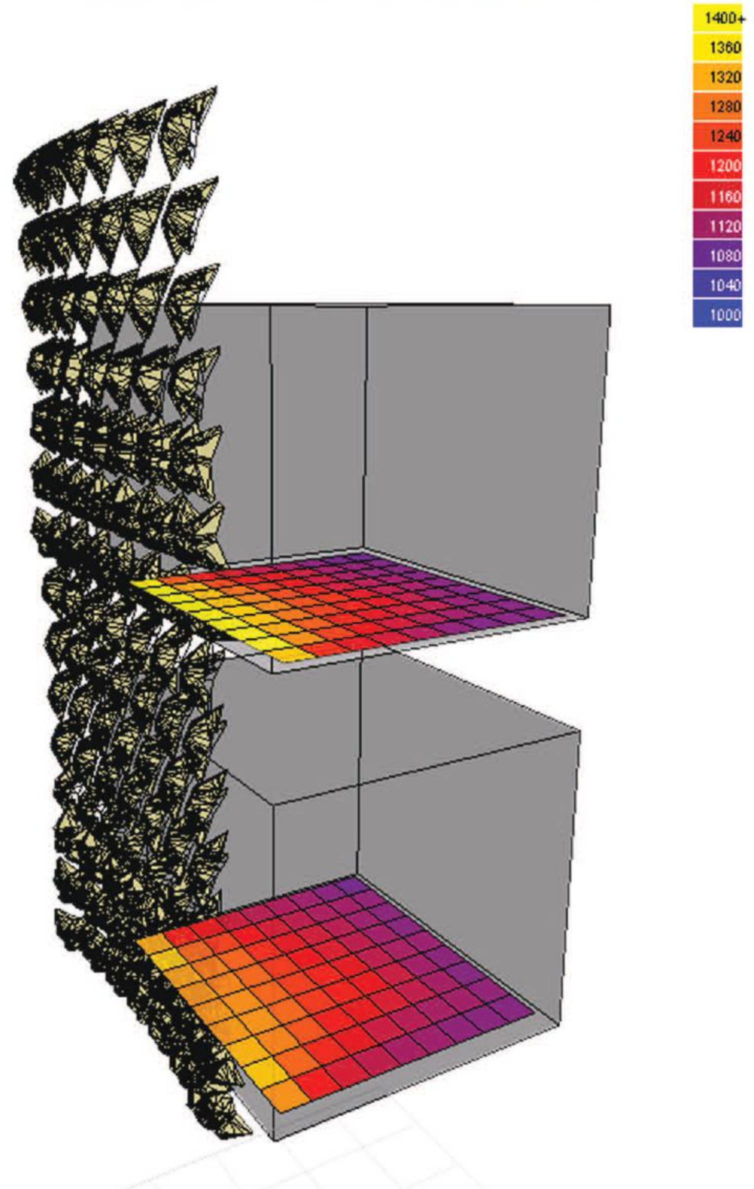
IMAGE SAMPLED



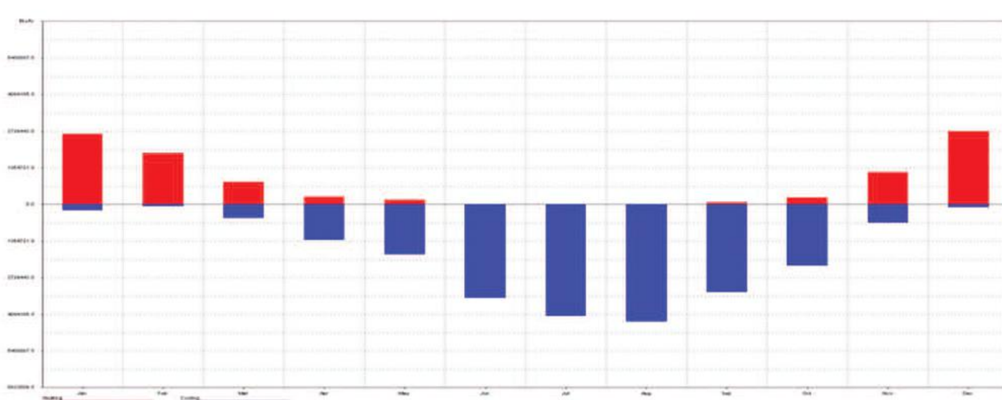
FACADE CONFIGURATION



CUMMULATIVE RADIATION MAP FOR JAN. 21



ANNUAL HVAC LOAD CYCLE GRAPH



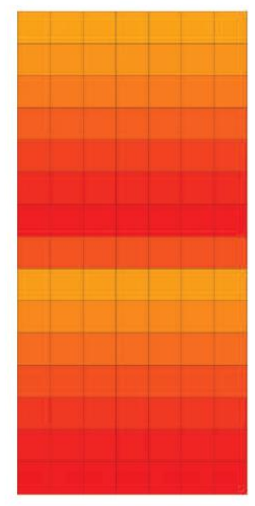
ANNUAL HVAC LOAD CYCLE GRAPH

Zone: Zone 2
Operation: Weekdays 08-19, Weekends 00-24.
Thermostat Settings: 70.0 - 75.0 F

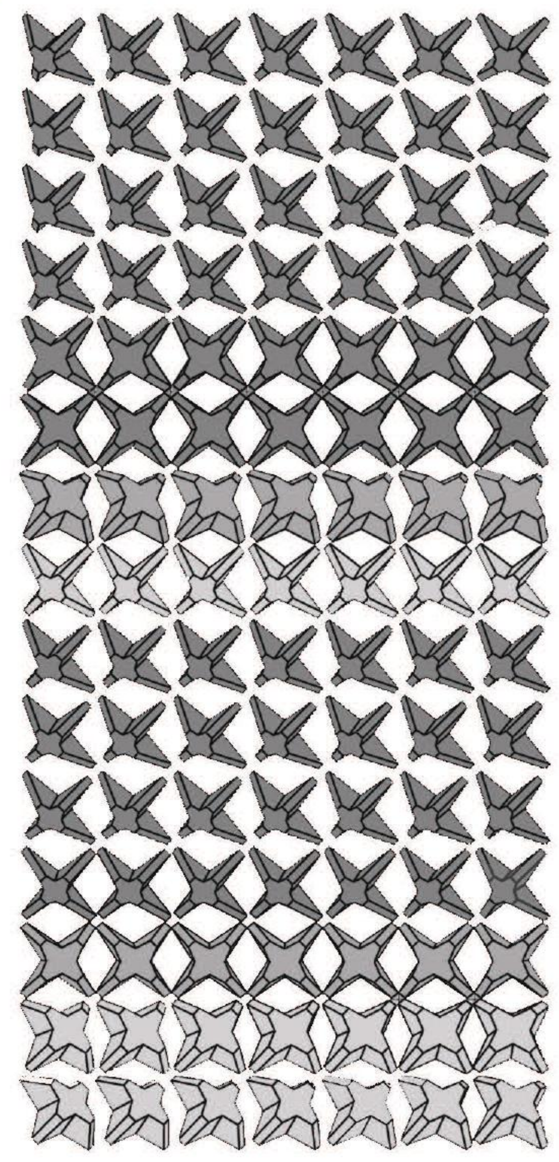
Max Heating: 17967.9 Btu/hr at 07:00 on 28th January
Max Cooling: 22077.4 Btu/hr at 13:00 on 19th November

		HEATING	COOLING	TOTAL
MONTH		(Btu)	(Btu)	(Btu)
TOTAL		10062778	22368236	32431014
PER M²		335728	746280	1082009
Floor Area:	322.63 ft2			

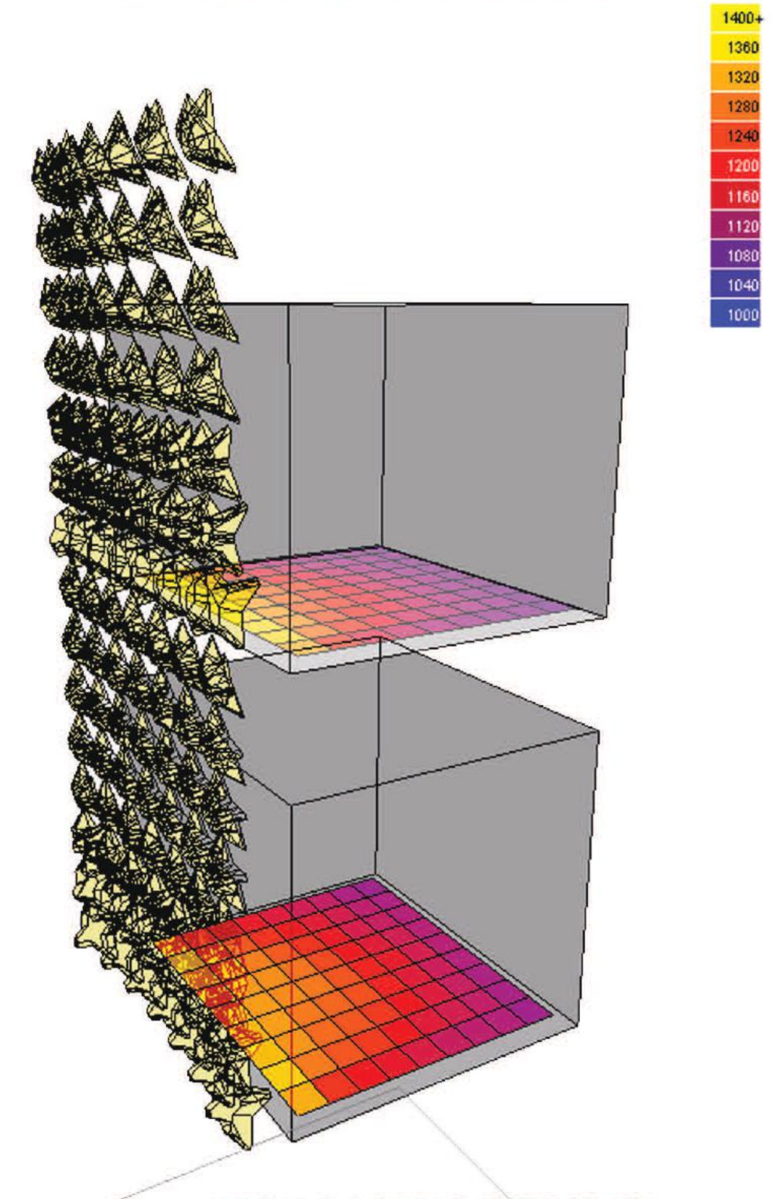
IMAGE SAMPLED



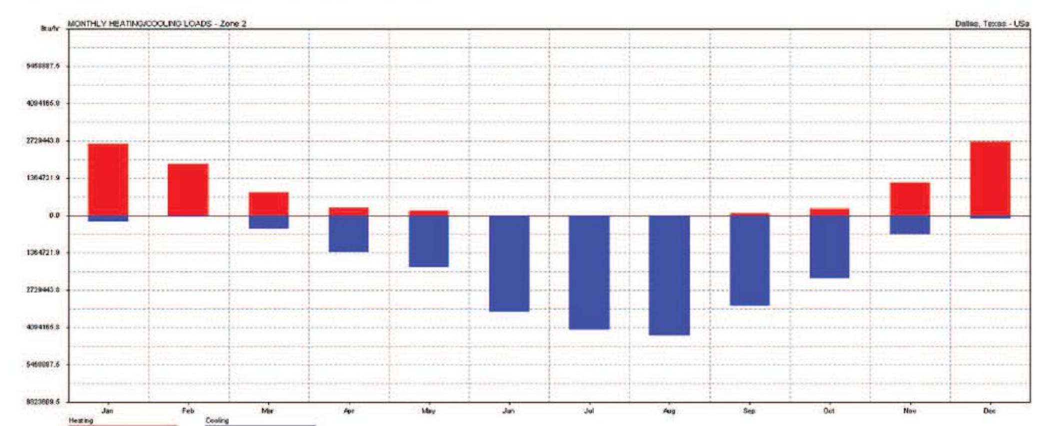
FACADE CONFIGURATION



CUMMULATIVE RADIATION MAP FOR JAN. 21



ANNUAL HVAC LOAD CYCLE GRAPH



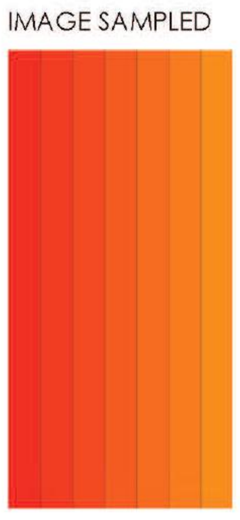
ANNUAL HVAC LOAD CYCLE GRAPH

Zone: Zone 2
Operation: Weekdays 08-19, Weekends 00-24.
Thermostat Settings: 70.0 - 75.0 F

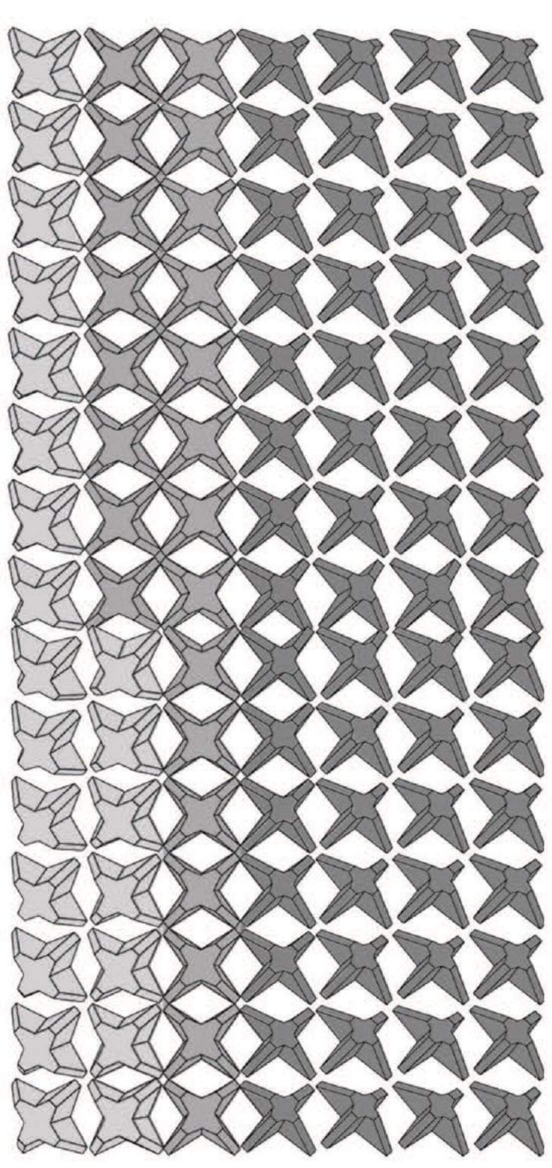
Max Heating: 17967.9 Btu/hr at 07:00 on 28th January
Max Cooling: 22086.1 Btu/hr at 13:00 on 19th November

		HEATING	COOLING	TOTAL
		(BTu)	(BTu)	(BTu)
TOTAL		10048996	22411944	32460940
PER M²		335269	747739	1083007
Floor Area:	322.63 ft2			

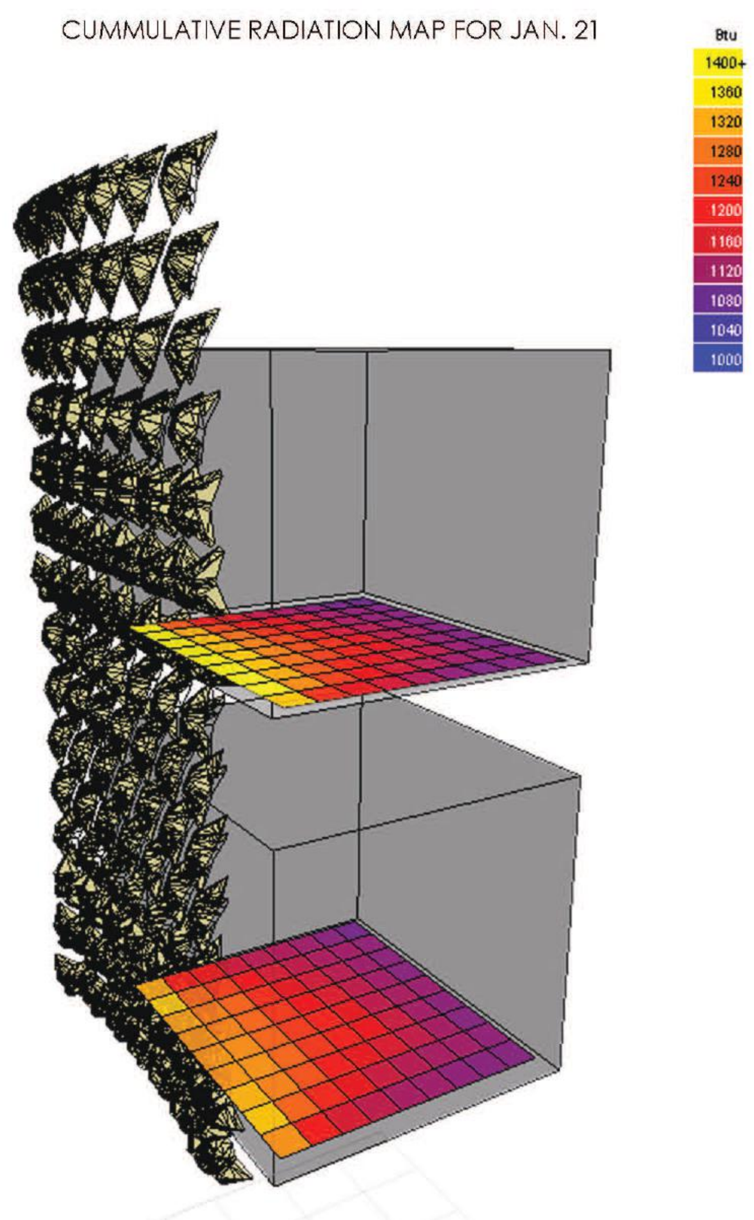
IMAGE SAMPLED



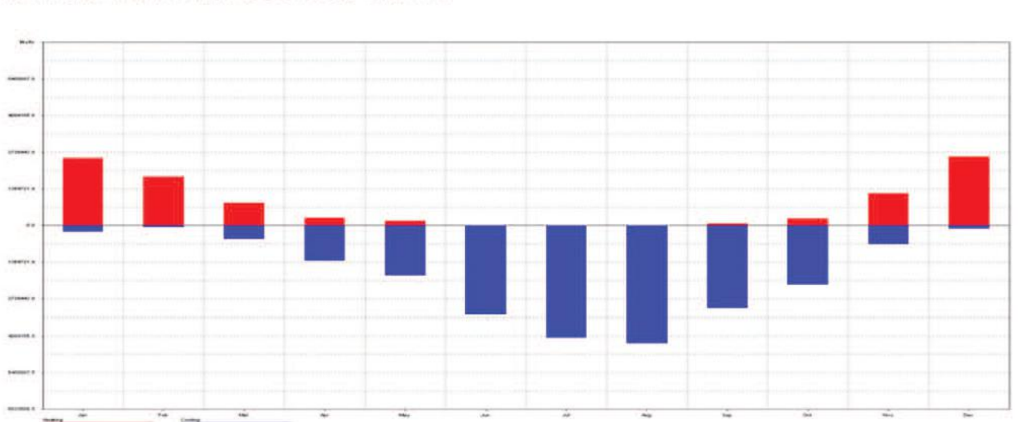
FACADE CONFIGURATION



CUMMULATIVE RADIATION MAP FOR JAN. 21



ANNUAL HVAC LOAD CYCLE GRAPH



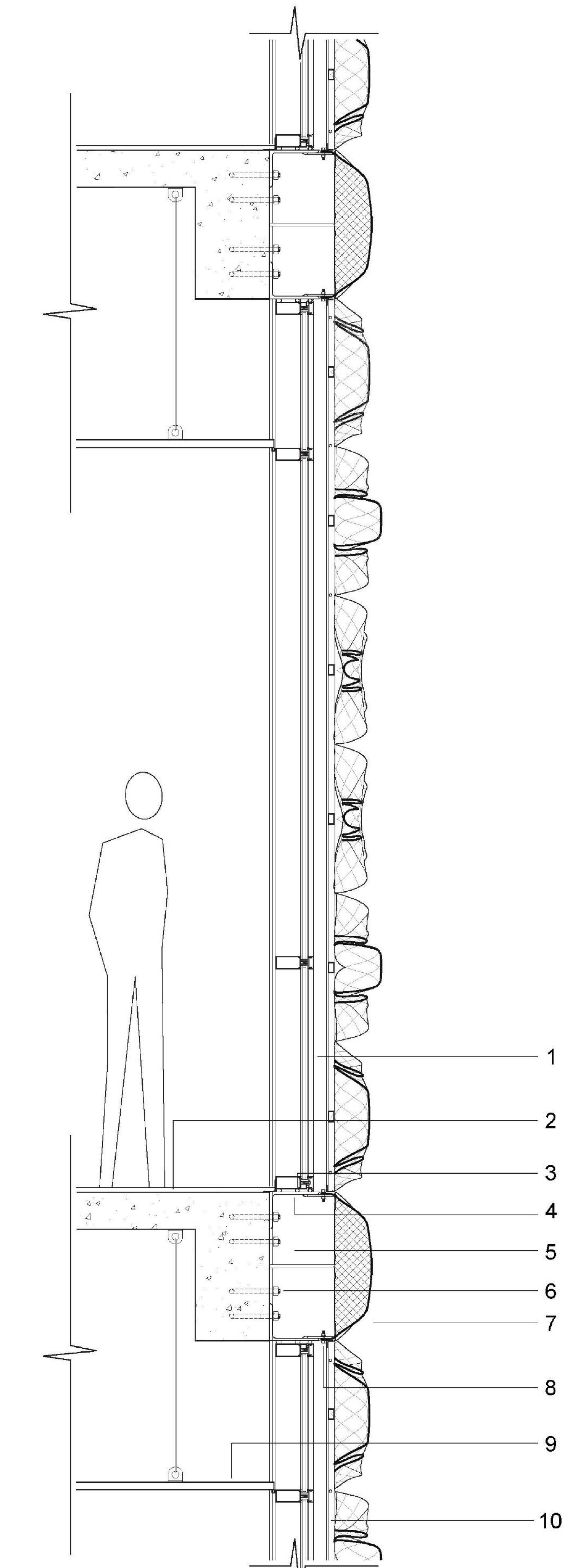
ANNUAL HVAC LOAD CYCLE GRAPH

Zone: Zone 2
Operation: Weekdays 08-19, Weekends 00-24.
Thermostat Settings: 70.0 - 75.0 F

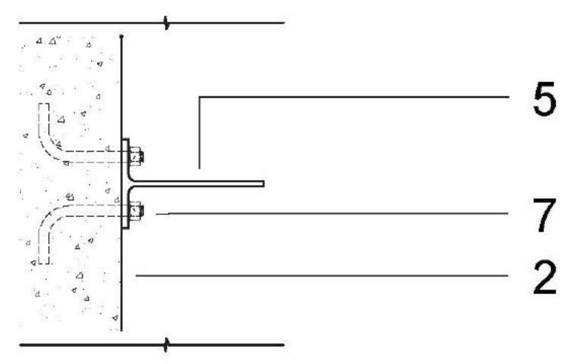
Max Heating: 17967.9 Btu/hr at 07:00 on 28th January
Max Cooling: 22077.4 Btu/hr at 13:00 on 19th November

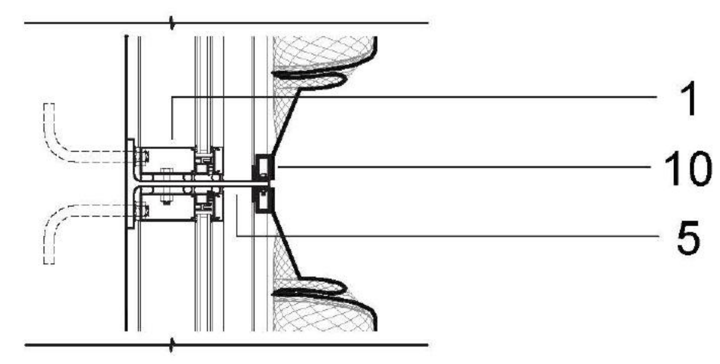
		HEATING	COOLING	TOTAL
MONTH		(Btu)	(Btu)	(Btu)
TOTAL		10062778	22368236	32431014
PER M²		335728	746280	107549
Floor Area:	322.63 ft2			

_CONSTRUCTION/**DETAILING**



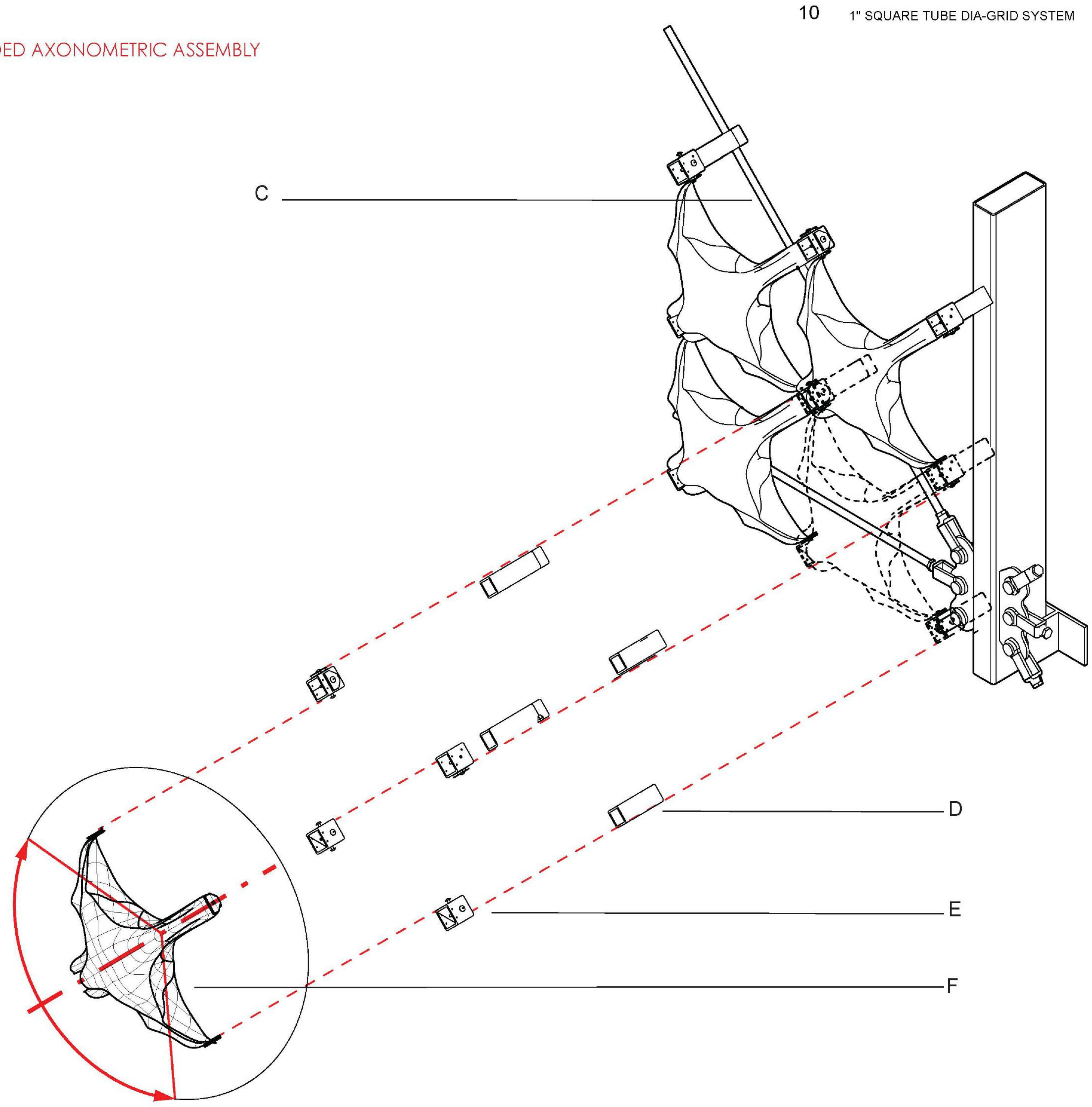
SYSTEM CONSTRUCTION:

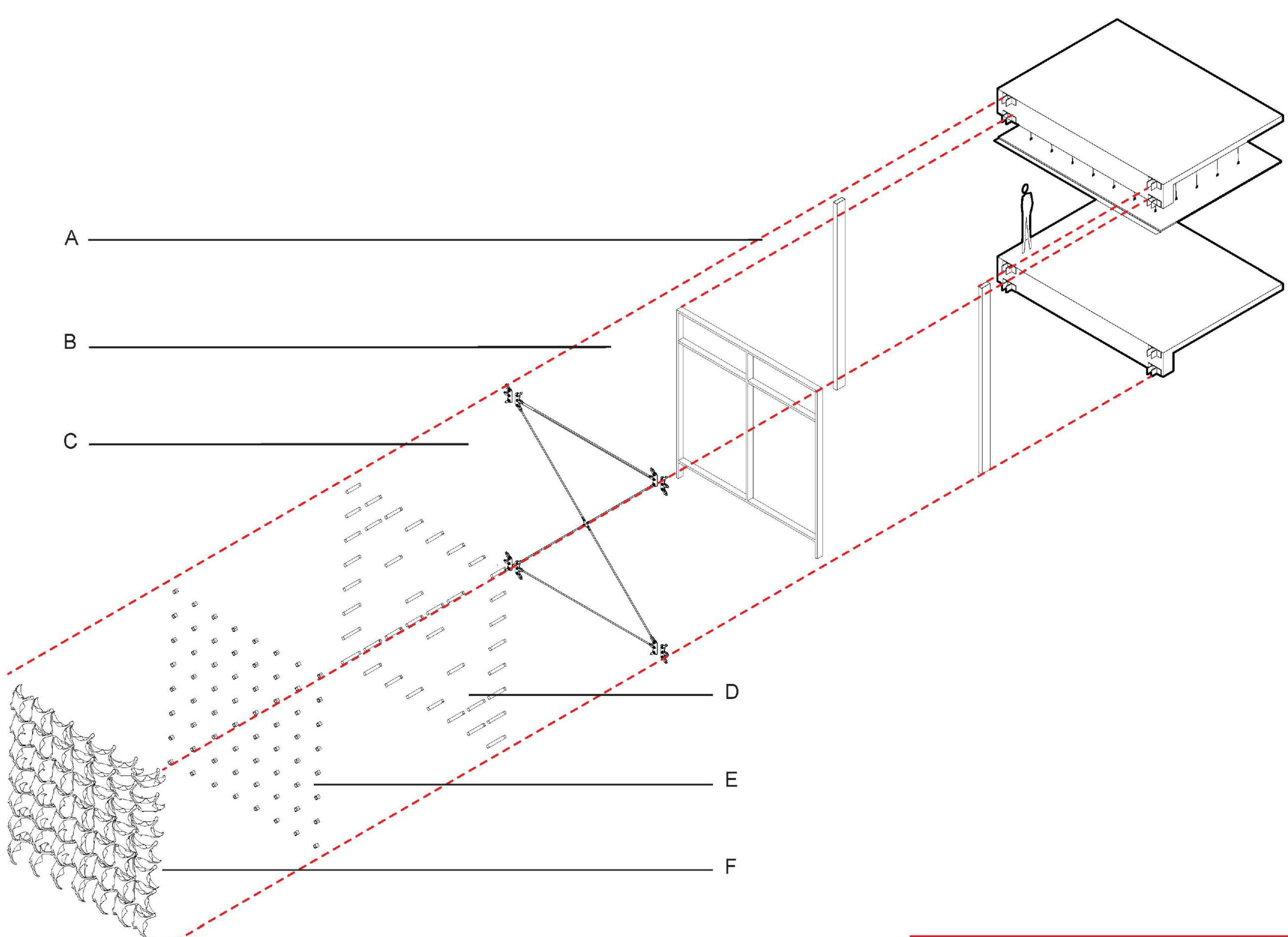




1 STORE FRONT WINDOW SYSTEM
2 STRUCTURAL FLOOR SLAB
3 SHIM SPACER AND BACKER ROD SEA
4 6 x 8 STEEL ANGLE
5 WT 10.5 x 25 STRUCTURAL TEE
6 ¾" SLAB ANCHORS
7 INSULATED SPANDREL PANEL TYP.
8 ⅜" HEX- BOLT, NUT AND WASHERS
9 LAY-IN CEILING
10 1" SQUARE TUBE DIA-GRID SYSTEM

EXPLODED AXONOMETRIC ASSEMBLY





INNOVATIVE FACADE SYSTEMS
eddie castañeda | bryan nors | donovan howard | matt morris

_ PROTOTYPE FABRICATION