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EMERGING OBJECTS

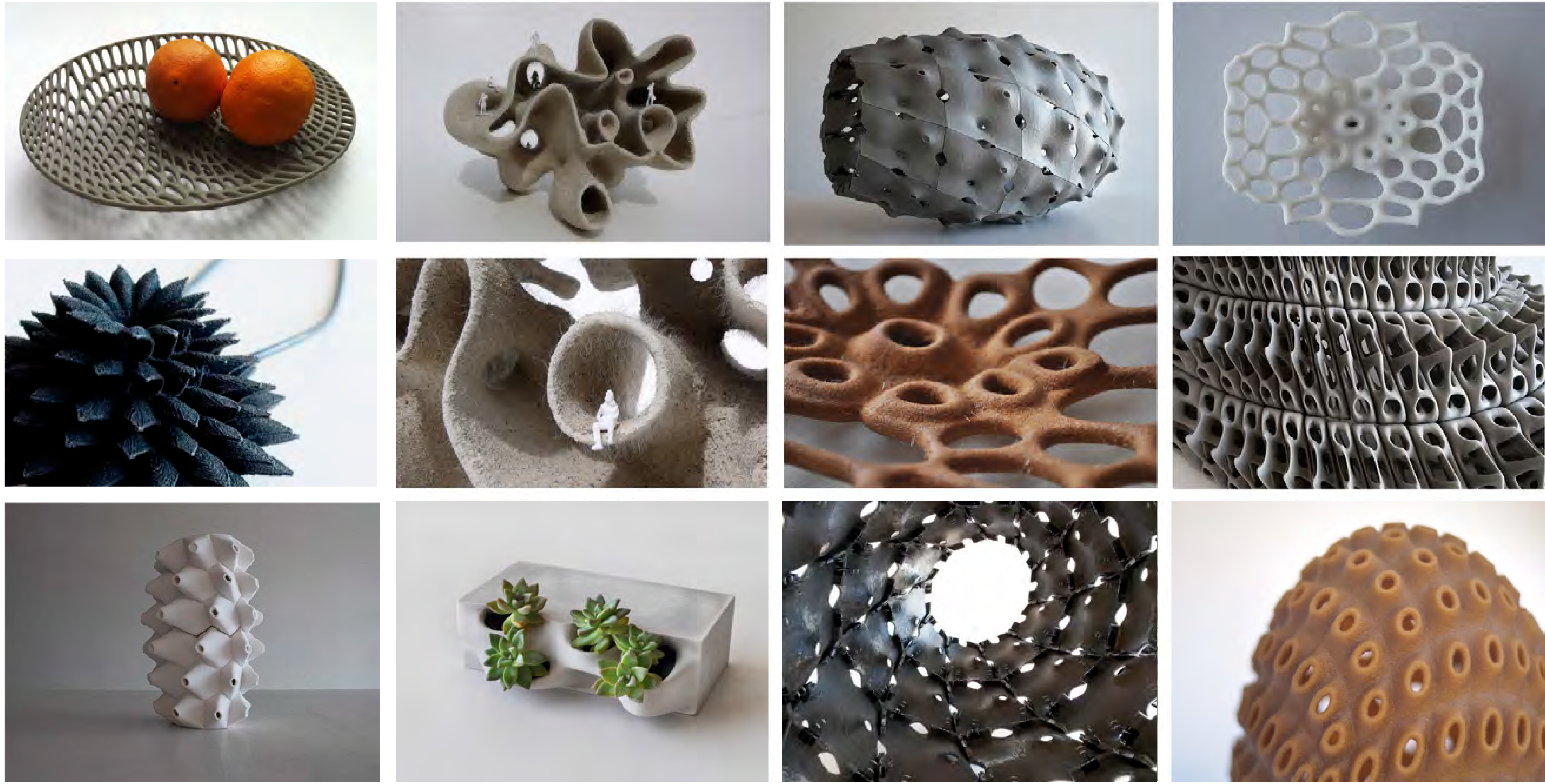
Project Date: 2010 -ongoing
Project Team: Ronald Rael, Virginia San Fratello, Emily Licht, Kent Wilson, Nick Buccelli, Bryan Allen

MISSION
Emerging Objects is a pioneering design and research company that specializes in designing and 3D printing objects for the built environment.

ABOUT
Our research and designs focus on the development of innovative 3D printed objects that serve the fields of architecture, interior design, furniture design and product design. Our design research has served as the foundation for our consulting projects and we work with a range of industrial partners, nonprofit foundations and creative practices.

VISION
Emerging Objects is interested in the creation of 3D printed buildings, building components and interior accessories that can be seen as sustainable, inexpensive, stronger, smarter, recyclable, customizable and perhaps even reparable to the environment. We want to 3D print long-lasting performance-based designs for the built environment using raw materials that have strength, tactility, cultural associations, relevance and beauty.

Because the inherent nature of 3D printing opens new possibilities for shaping materials, this process will reshape the way we as a society think about manufacturing and construction. Though rapid manufacturing, geometries can be created that would be impossible to create by hand or require expensive machinery to produce or reproduce. Because additive manufacturing requires no dies or molds, products can be mass-customized, employing the flexibility of computer-aided manufacturing systems, rather than mass- produced, allowing design parameters to be quick. 3D printing is also a fabrication method that minimizes waste which makes it an environmentally conscious method of manufacturing.



3D Printed items in cement polymer, nylon, salt, wood and sand

EARTHSCRAPER: Developing 3D printing for the rapid manufacture of sand-based building components

Project Date: 2010
Project Team: Ronald Rael, Virginia San Fratello, John Faichney, Maricela Chan, Chris DeHenzel, Emily Licht

SUMMARY

The creation of building components that can be seen as sustainable, inexpensive, stronger, recyclable, customizable and perhaps even reparable to the environment is an urgent, and critical focus of architectural research. In the U.S. alone, the construction industry produced 143.5 million tons of building-related construction and demolition debris in 2008, and buildings, in their consumption of energy produce more greenhouse gasses than automobiles or industry.

Because the inherent nature of 3D printing opens new possibilities for shaping materials, the process will reshape the way we think about architectural building components. Digital materiality, a term coined by Italian and Swiss architects Fabio Gramazio and Matthias Kohler, describes materiality increasingly enriched with digital characteristics where data, material, programming and construction are interwoven. The research aspires towards this classification through the use of parametric modeling tools, analytic software and quantitative and qualitative analysis.

Rapid Prototyping, which is the automatic construction of physical objects using additive manufacturing technology, typically employs materials intended for the immediate analysis of form, scale, and tactility. Rarely do the materials used in this process have any long-term value nor does the process, except in rare cases with expensive metal prototyping, have the ability to create actual and sustainable working products.

3D printed sand display table

This research intends to alter this state of affairs by developing methods for 3D printing using concrete for the production of long-lasting performance-based components.

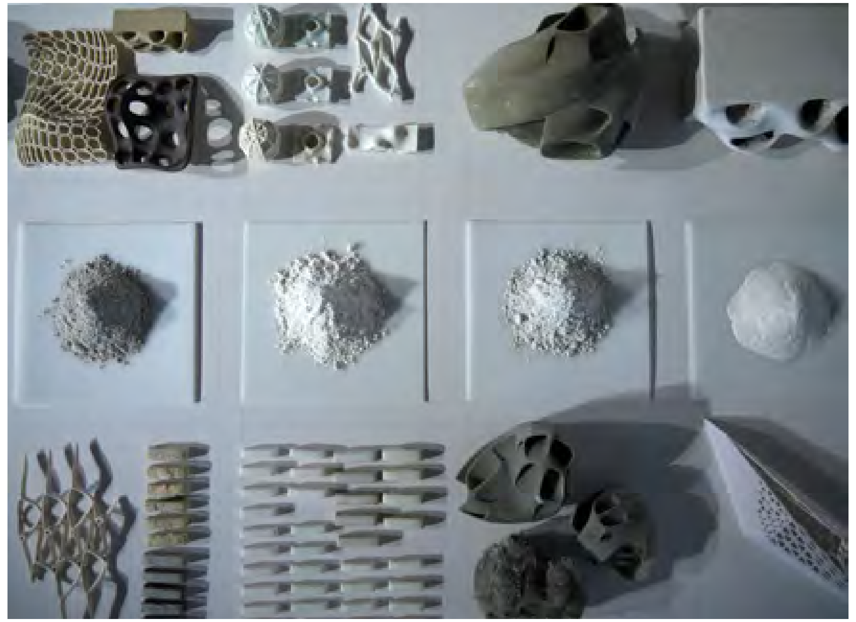
MATERIAL INFORMATION

The word concrete comes from the Latin word "concretus" (meaning compact or condensed), the perfect passive participle of "concresco", from "com-" (together) and "cresco" (to grow). The development of concrete has evolved for over two thousand years. The Romans used quicklime, pozzolana and aggregate or rubble to build concrete structures such as the Pantheon and the Baths at Caracalla. In 1756 John Smeaton rediscovered concrete by mixing hydraulic lime and powdered brick as aggregate. These mixtures produced concrete with a comprehensive strength comparable to the mixes that we use today. The mixes that we most frequently use today include:

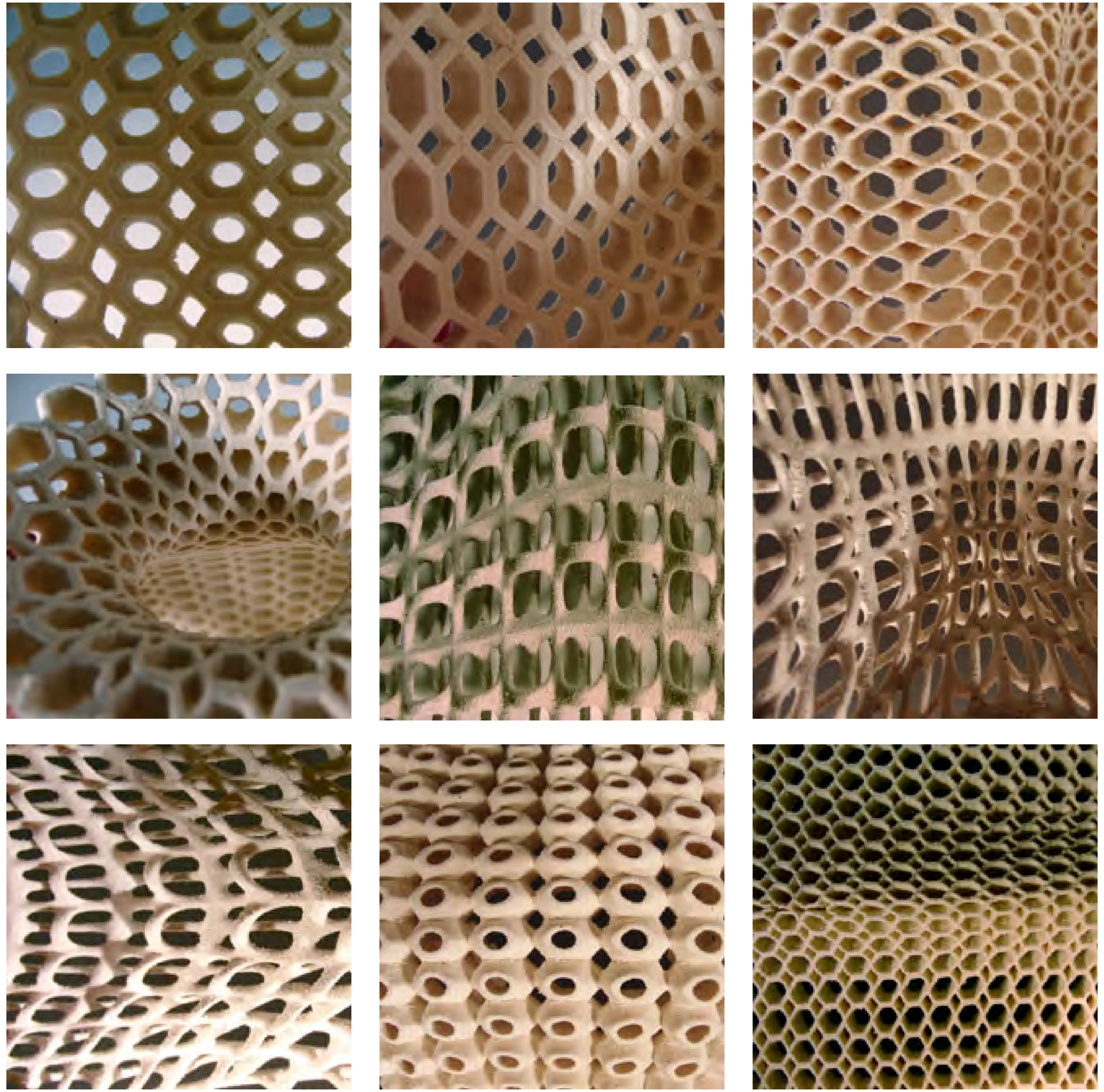
Portland cement: which consists of a mixture of oxides of calcium, silicon and aluminium. Portland cement and similar materials are made by heating limestone (a source of calcium) with clay, and grinding this product (called clinker) with a source of sulfate (most commonly gypsum).

Water: Combining water with a cementitious material forms a cement paste by the process of hydration.

Aggregates: Fine and coarse aggregates make up the bulk of a concrete mixture. Sand, natural gravel and crushed stone are mainly used for this purpose. Recycled aggregates (from construction, demolition and excavation waste) are increasingly used as partial replacements of natural aggregates, while a number of manufactured aggregates, including air-cooled blast furnace slag and bottom ash are also permitted.



right: studies of 3D printed porcelain and ball clay



When initially mixed together, Portland cement and water rapidly form a gel, formed of tangled chains of interlocking crystals. These continue to react over time, with the initially fluid gel often aiding in placement by improving workability. As the concrete sets, the chains of crystals join up, and form a rigid structure, gluing the aggregate particles in place. During curing, more of the cement reacts with the residual water (hydration).

Concrete is inherently weak in tension as the cement holding the aggregate can crack. The addition of steel reinforcement to concrete in the 19th century solved this problem. In addition to adding steel reinforcing bars, we now add steel fibers, glass fiber, or plastic fiber to carry tensile loads. Thereafter the concrete is reinforced to withstand the tensile loads upon it.

The mix for use in the 3d printer is similar to yet varies in composition from the traditional mixes used. The traditional processes used vary dramatically, from hand tools to heavy industry, but result in the concrete being placed in a formwork where it cures into a final form. In the case of 3d printing concrete there is no form work or mould. There is however, the constraint that all binding particles used in the concrete mix must fit through a 35 picoliter print head and all cement, aggregate and reinforcement must be smaller than 0.010”. The mix that is used in the 3D printer is made of:

Portland cement
Finely graded sand
Powdered sugar
Maltodextrin
Rice wine
Nylon fibers

below: 3D printed sand structure
right: Tower printed in 4 pieces and stacked together at interlocking sections

The Portland cement serves the same purpose as it does in a traditional mix. The finely graded sand, sugar and maltodextrin act as the aggregates. The rice wine is composed of 80% water and acts as the binder, although a slurry is not formed, and the nylon fibers serve as reinforcement.

HOW IT WORKS

The 3D printer lays down a thin layer of the dry, powdered concrete mix, then using an ink jet sprays the image of one 'slice' of the 3D object or in this case CMU (concrete masonry unit) onto the dry mix. The wet parts of each layer hydrate into rock-hard concrete, and the rest remains in a powder form which can be brushed off later. Because concrete cures via a chemical reaction – hydration- no air is required for curing, so the next layer can be deposited immediately.

The cycle of laying down concrete and binder with the rice wine is repeated over and over, stacking layer upon layer, building up a solid object inside the pile of dry, powdered concrete mix. The dry concrete mix acts as a support structure during the printing process, so objects may have undercuts which is unseen in traditional concrete casting.

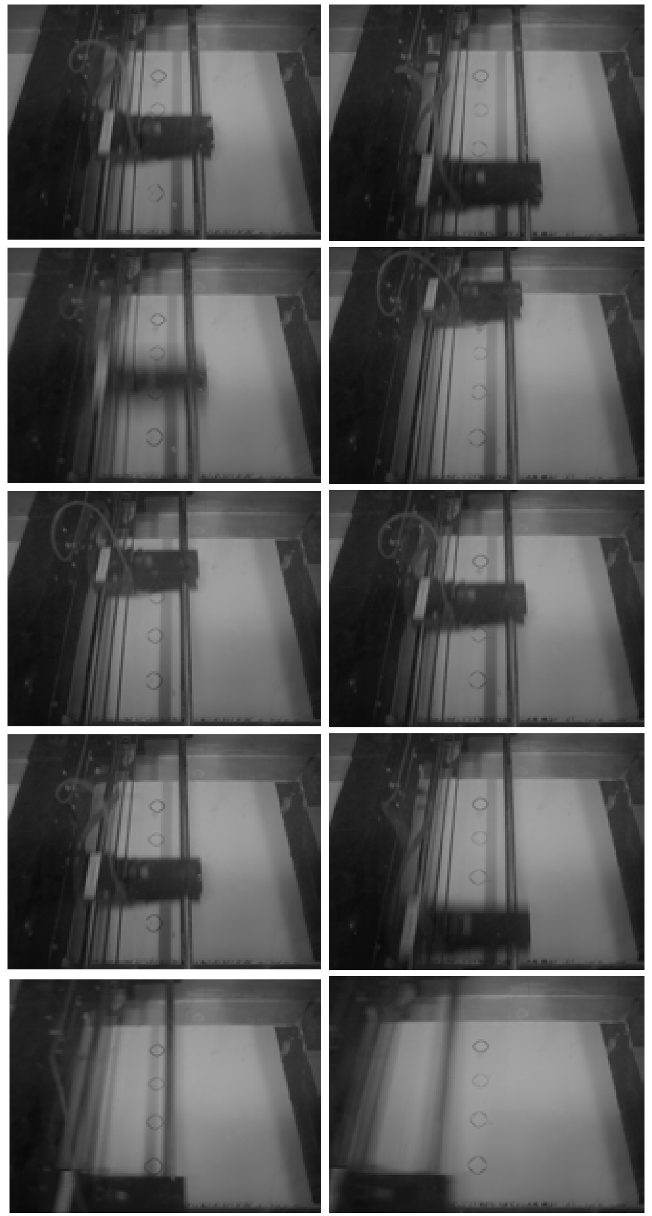
Once the concrete cures enough to handle, which typically takes about 12 hours, the finished object can be lifted out of the powder bed. The dry mix used to support the concrete object during printing can be recycled. Printing an intricate and unique concrete part would only consume a few dollars worth of material, would incur no cost for formwork and very little labor costs. Additionally compared to printing with z corps proprietary blend, the costs are considerably lower. The Z corp polymer / plaster powder, at it's cheapest, is $3 a cubic inch and the 3D printed concrete costs mere cents per cubic inch.

Concrete Media:

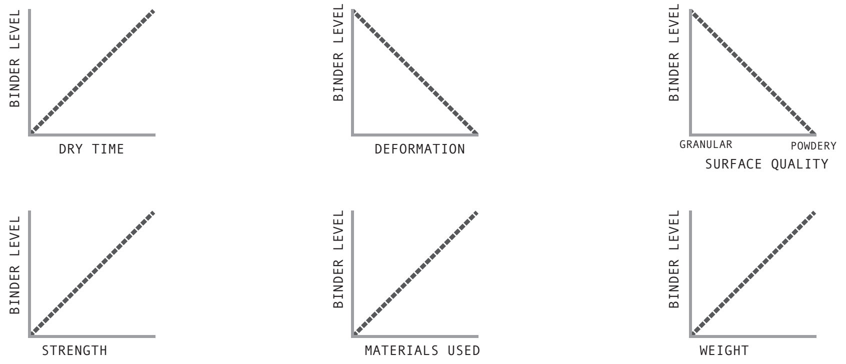
The initial impetus to work with concrete as a 3D printed material was driven by an installation we designed called Earthscapers. Earthscrapers imagines the potential of employing Computer Aided Design (CAD) and Computer Aided Manufacturing (CAM) processes in the construction of a proto-architectural landscape—one where the building material source and the building itself are seamless. The project also imagines a future scenario for the material and the process as a scalable technology—one that also dissolves the role of the architect and builder. We imagined printing full scale buildings with in situ aggregates in a world where designer and geomorphologist merge.

The capability to 3D print at the scale of the building is gaining momentum and is certain to occur. Currently the largest 3D printer in the world is a 10' x 10' x 10' 3-D stereolithic printer that creates models entirely out of artificial sandstone using CAD-CAE modeling technologies and CAD-CAM software to control the plotter. The printing proceeds in 5-10mm layer segments and, in the end, produces a structure that has strength characteristics reminiscent of standard Portland Cement. This printer can print a low resolution room.

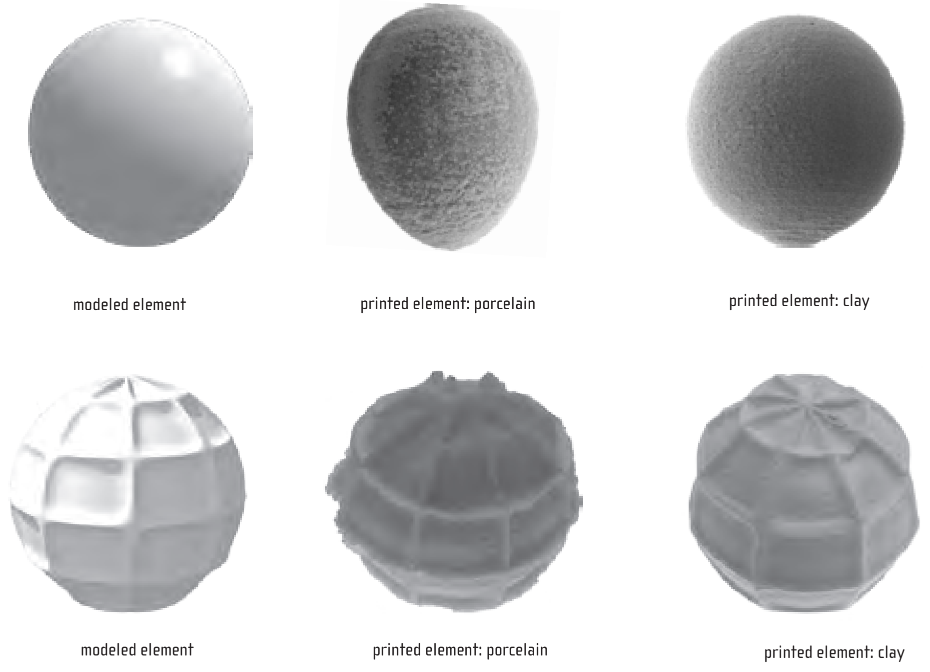
Dr. Behrokh Khoshnevis, of the University of Southern California has developed a different printing technique called Contour Crafting (CC). Contour crafting is a layered fabrication technology that has potential for automating the construction of whole structures as well as sub-components. Using this process, a single house or a colony of houses, each with possibly a different design, may be automatically constructed in a single run, embedded in each house all the conduits for electrical, plumbing and air-conditioning. They have recently collaborated with Catepillar to fabricate a 6 foot wall.



EFFECTS OF BINDER LEVELS:

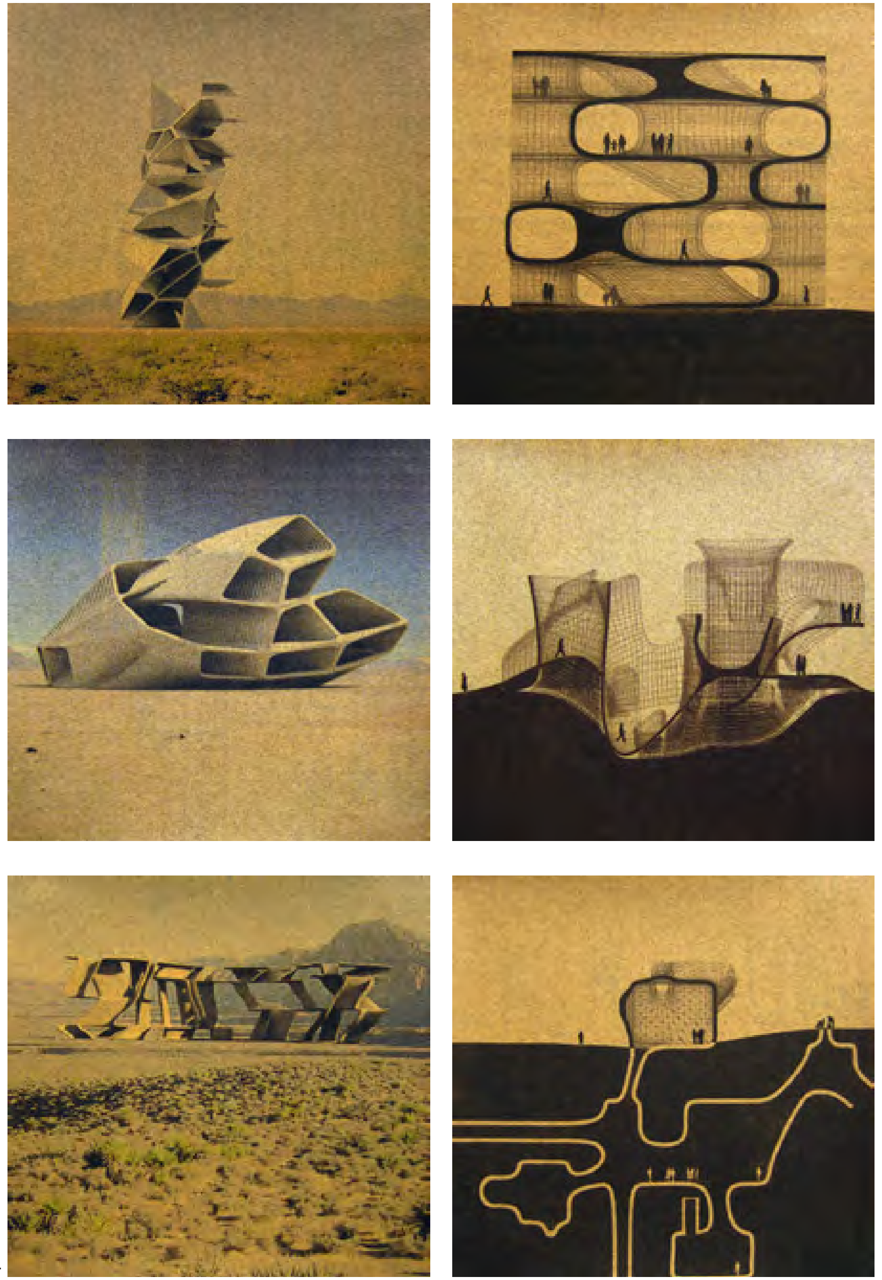


MATERIAL DEFORMATION



For the Earthscrapers exhibit we were uniquely interested in connecting the 3D printed material to the landscape therefore we started by printing various materials including clays, sands and ashes. Ultimately we decided to print a small amount of portland cement mixed with a large portion of sand. The resulting concrete prints proved to be very stable, strong and have the effect of looking like earth due to the amount of natural aggregate within the mix.

The plastic nature of both concrete and 3D printing offer up a powerful material solution to recent generative design processes in architecture, which often feature organic, doubly curved surfaces and complex ornamentation. The Earthscrapers exhibit explored a range of complexly curved forms. It also explored thinness and attempts to push the limits in terms of extracting thin surfaces and thin structural elements from the printer bed. Several of the complexly curved, fiber reinforced concrete prints were easily 1/16" of an inch thick which would be very difficult, if not impossible, to cast using traditional methods of mould making. Making the 3D printed models and objects that were on display in the Earthscraper exhibit was an active process where software, geometry, material, fabrication and production were simultaneously linked. The complexity of form was limited by thinness and slump. If the form was not allowed to cure in the bed for at least 12 hours the concrete object would fail. The success of the mix depended on the amount of binder being laid down at each successive interval. For example, if the binder was sprayed at full capacity the concrete print would slump therefore the binder level should be set at .75.

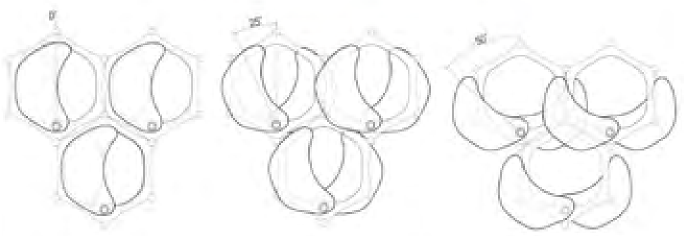


Drawings printed on sand paper

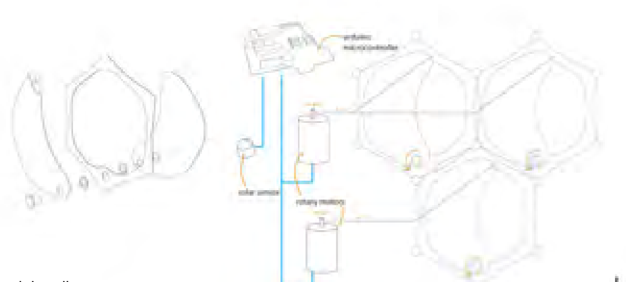
HEX CURTAIN:
Developing 3D printing for the rapid manufacture of facade elements

Project Date: 2011
Project Team: Ronald Rael, Virginia San Fratello, Chase Lunt

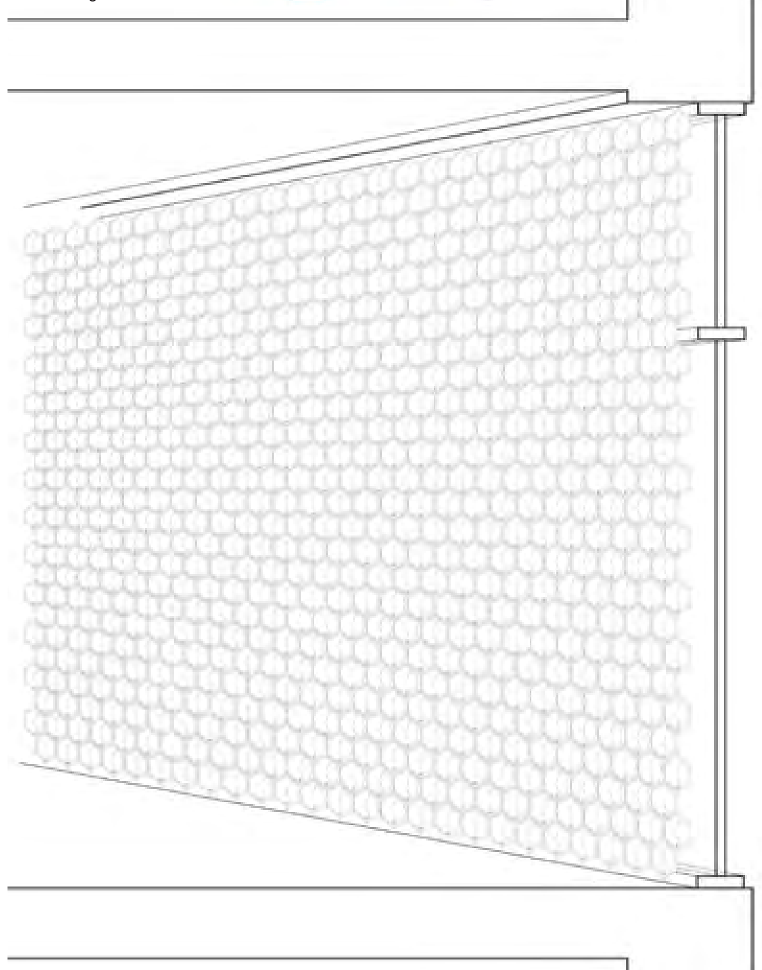
The HEX curtain is designed to open and close automatically in response to natural daylighting conditions. Each row of the HEX curtain is composed of hexagonal shaped apertures that are covered by 2 operable shields. lds have the ability to pivot open and closed. The shields are hinged at the bottom and threaded at the top. The top thread connects each shield to the one next to it. At the end of each row a rotary motor pulls the thread and slowly opens or closes the shields in tandem. motor is driven by an arduino microcontroller connected to a solar sensor so on a sunny summer day the shields remain closed and on a sunny winter day the sheilds are automatically opened to allow sun to enter the interior and warm the space. The HEX curtain is constructed of laser sintered nylon and is 3D printed in 27” x 22” panels.



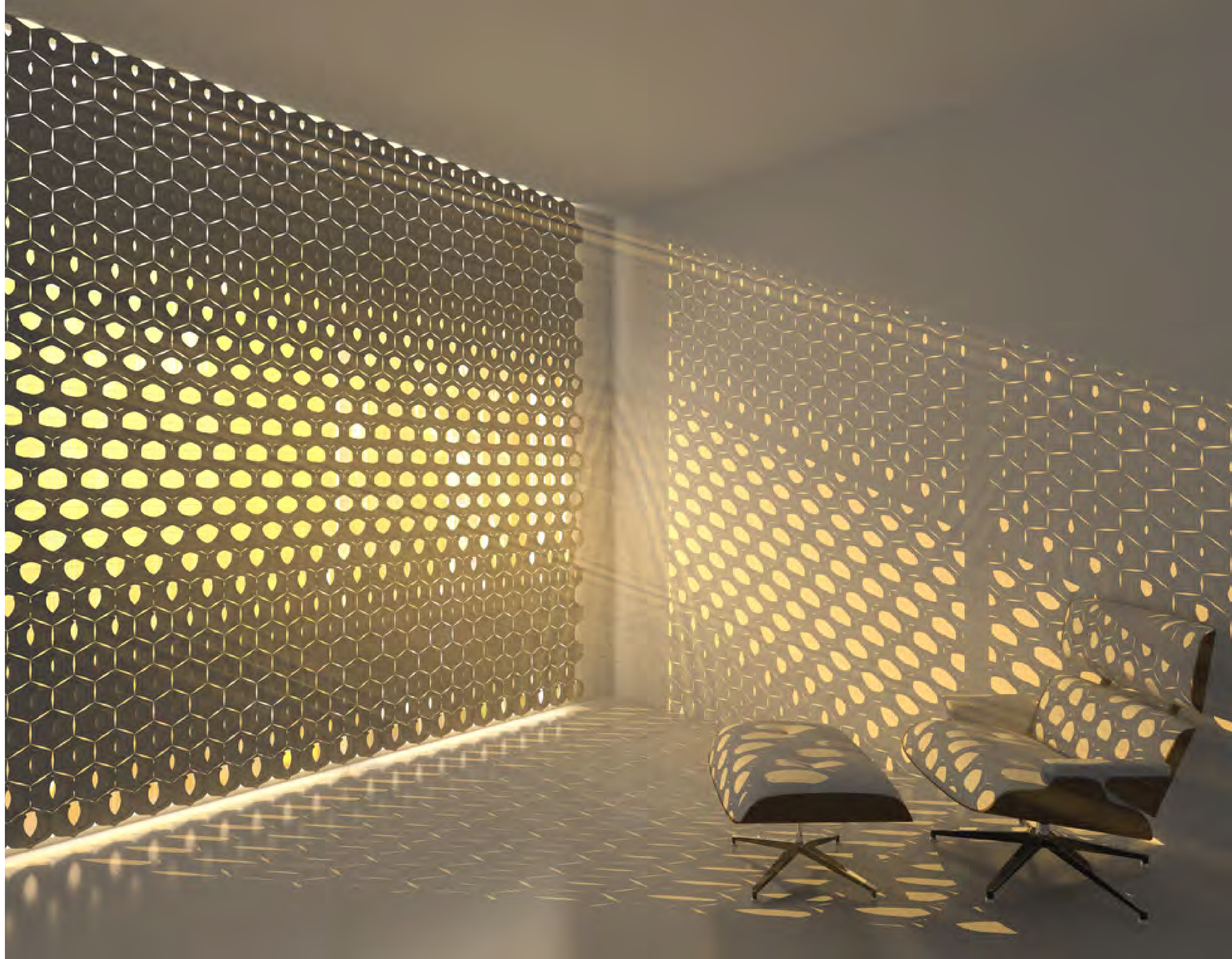
above: opening and closing sequence
below: 3D printed prototype



arduino diagram



sectional perspective



PLANTER BRICK WALL: Developing 3D printing for the rapid manufacture of clay building components

Project Date: 2011
Project Team: Ronald Rael, Virginia San Fratello, Molly Reichert

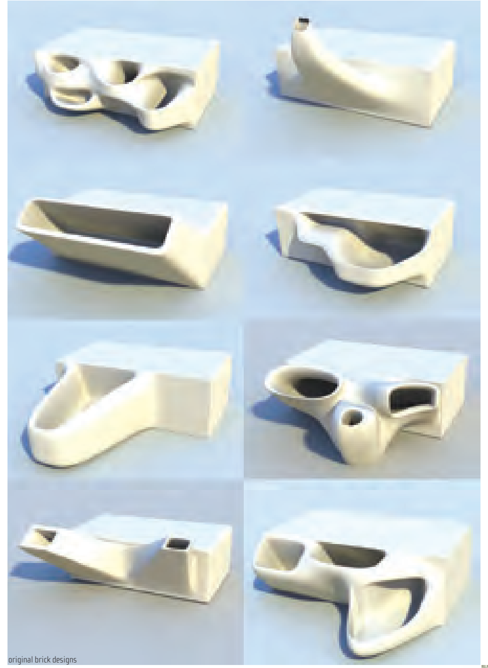
The planter brick wall is designed to be a combination of traditional masonry units combined with units that can hold plants and vegetation. Most plants do not need much, if any, soil but they do need water and nutrients. The plants held in the planter bricks will be fed water and nutrients through drip irrigation lines that are built into the cavity of the masonry wall.

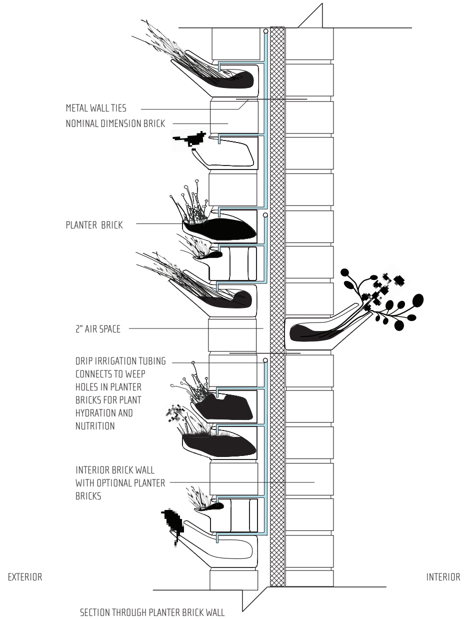
The planter bricks have the potential to counter the heat island effect in big cities through evapotranspiration and pollution conversion and by the light, reflective color of the bricks. Additionally, edible plants such as rosemary and other fragrant herbs with shallow root systems may be planted in the bricks and accessed through openings in the wall. The plants in the bricks will help mediate the temperature of the microclimate surrounding the building, buffer sound and filter the air.

The planter bricks are made by direct digital manufacturing and rapid prototyping technology. Ceramic particles are printed and held together unsing an organic binder and then fired in a kiln just like traditional bricks. The bricks may be assembled in a load bearing cavity wall condition or installed as a traditional masonry curtain wall would be on a steel or concrete frame building and can be installed new or retrofitted.

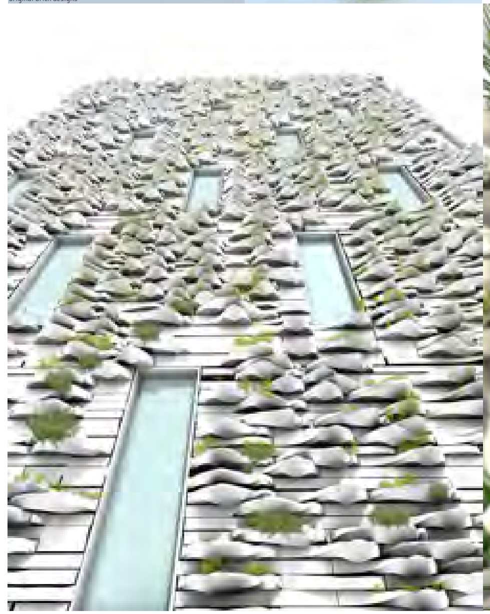
The planter bricks shown here have all been 3D printed using direct digital manufacturing . The bricks are modeled in a 3D software application and the digital file is sent directly to the 3D printer for manufacture. This means a very diverse and infinitely unique selection of bricks can be manufactured based on the clients or designers desires for a particular application.

The bricks are manufactured with clay instead of more ephemeral powders that are typically used for rapid prototyping. The 3d clay prints are then bisque fired at cone 5 and glazed to make them waterproof.


original brick designs



SECTION THROUGH PLANTER BRICK WALL
SCALE : 2 1/2" = 1'-0"



2

3D printed clay wall assembly

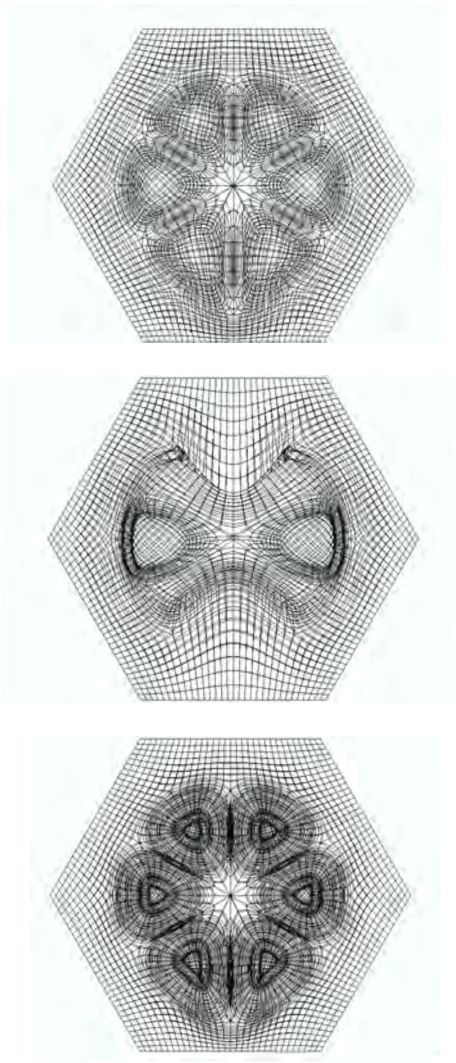
3D printed clay brick glazed white

PLANTER TILES

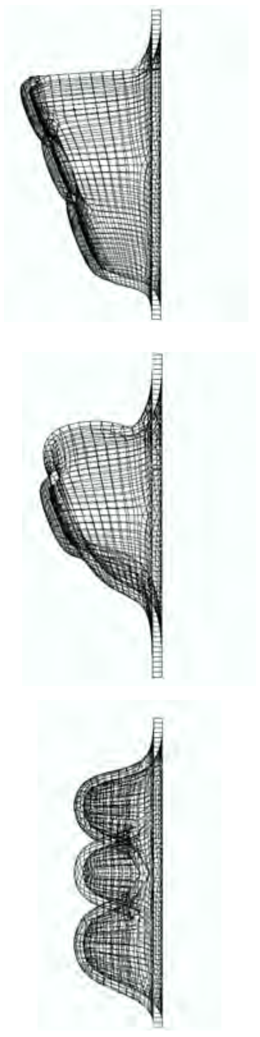
Project Date: May. 2014

Project Team: Ronald Rael, Virginia San Fratello

The Planter tiles are 3D printed cement hexagonal tiles that close pack together. The overall pattern is composed of 6 different tile patterns, 4 of which have the capacity to hold plant life. The petal motif on the tiles themselves ties together the planter tiles and non planter tiles through the use of a 3 dimensional graphic. The planter tiles are one of the first commercial applications of the 3D printed cement.



Front View of Tiles



Side View of Tiles

3D PRINTED JEWELRY

Project Date: May 2013-Current

Project Team: Ronald Rael, Virginia San Fratello

The 3D printed jewelry started as an investigation into the potential of form making and complexity in 3D printing. The jewelry tests minimum thicknesses, excavation, casting, various coloration techniques and is often a small scale study model for a larger piece.

Jewelry can be customized to fit different bodies and can be scaled proportionally to appeal to different end users. It is the beginning of an investigation into 3D printing for the body and for fashion.

The Picoroco rings shown below are designed based on the form of a barnacle. They are hand dyed different colors so that even if multiple rings are printed out of the same material the color is customizable - no two are the same. The picoroco rings are the inspiration for the Picoroco wall.

The Big Bloom rings are based on the form of the Dahlia.

The Involute necklace is a study in formal complexity and could not be fabricated any other way because of the doubly curving surfaces that intersect each other. It is a prototype for the Rupp Prize in Architecture and the Involute Wall.

Involute Necklace: 3D printed nylon

Picoroco Rings: 3D printed nylon

Big Bloom Rings: 3D printed nylon

DIGITAL DANDELIONS

Project Date: Oct. 2014

Project Team: Ronald Rael, Virginia San Fratello

The Digital Dandelions began as an exercise in experimenting with how to use one software command to create as many different forms as possible. Twenty unique ring designs were modeled in one day. The rings were printed in nylon, resin, steel, cement, aluminum, brass, and bioplastic. The rings were designed for the *BURST open* exhibit in Brisbane, Australia, at the Artisan Gallery. The rings are open source and can be downloaded at http://www.burstopen.org/author/virginia-san-fratello/ .

Blocky Ring: 3D printed nylon

Spacy Ring: 3D printed aluminum dust

Dandy Ring: 3D printed nylon

Spongy Ring: 3D printed brass

STARLIGHT

Project Date: Nov. 2014

Project Team: Ronald Rael, Virginia San Fratello

The Digital Dandelion rings inspired this series of light fixtures which are made using similar modeling techniques. In order to print at larger scales the lamps must be divided up into 3D printable parts that can be assembled. The parts are then modified with flanges and holes for mechanical fastening. The orange and white lamps are fabricated out of bio-plastic using an FDM printer (fused deposition modeler) and the large grey floor lamp is 3D printed out of white cement .

Starlight MINI

Starlight MEGA being assembled

Starlight MEGA

DAISY LAMP

Project Date: Nov. 2014

Project Team: Ronald Rael, Virginia San Fratello

The design for the daisy lamp comes from developing a technique where a 2 dimensional black and white image can be applied to a 3 dimensional form. The white areas in the image become almost solid and the black areas become perforated allowing for light to pass through the perforations to illuminate the pattern. Different color LED lights have been installed in the fixture to allow for color variation. The light is 3d printed out of white nylon.

2D black and white pattern

orange LED light

blue LED light

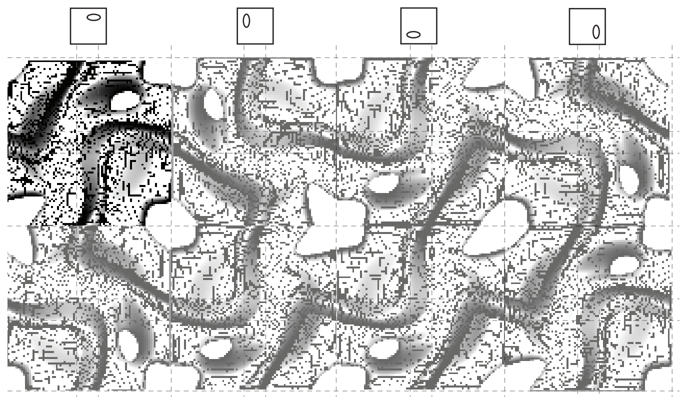
magenta LED light

SEAT SLUG:
Developing 3D printing for the rapid manufacture of structural cement-polymer building components

Project Date: 2010
Project Team: Ronald Rael, Virginia San Fratello, Kent Wilson, NIck Buccelli, Emily Licht

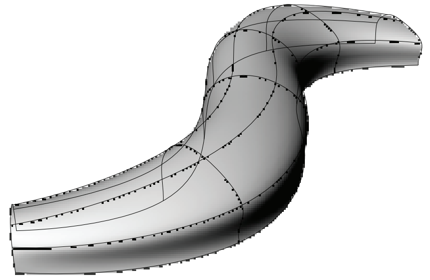
RSF has developed a cement-based polymer and a new process that,for the first time, employs conventional rapid prototyping hardware to produce strong and durable building components that cost far less than conventional rapid prototyping materials—up to 90% less than comparable powder printing materials. The material can also reach strengths of up to 4,700psi in compression. This advancement in material output from digital modeling software ushers in a new era in building materials, and a new synthesis of design and production.

The SeatSlug, a biomorphic interpretation of a bench, demonstrates how this new digital output process generates end-product structural building components directly from 3D software models. The design is inspired by flabellina goddardi, the newest species of sea slugs discovered in California in 2010, and by the infinite tessellations of Japanese karakusa patterns. It is constructed of 230 unique rapid-manufactured components.The sinuous form, subtle translucency and glossy finish engage viewers with a memorable aesthetic experience—a tactile personal encounter with a technological breakthrough.

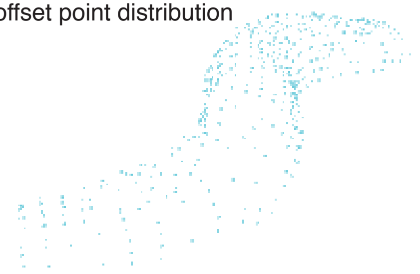


karakusa tiling pattern

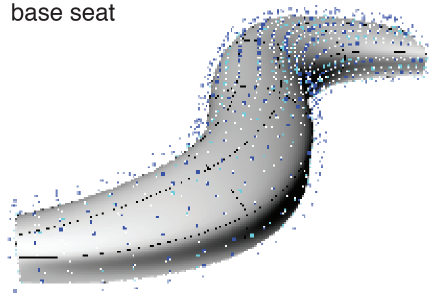
offset point distribution



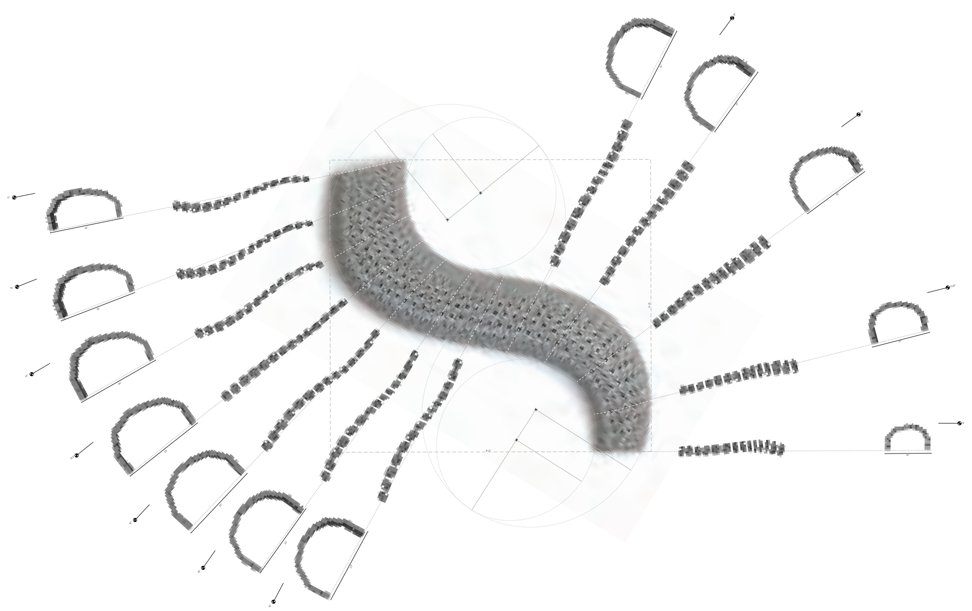
base seat

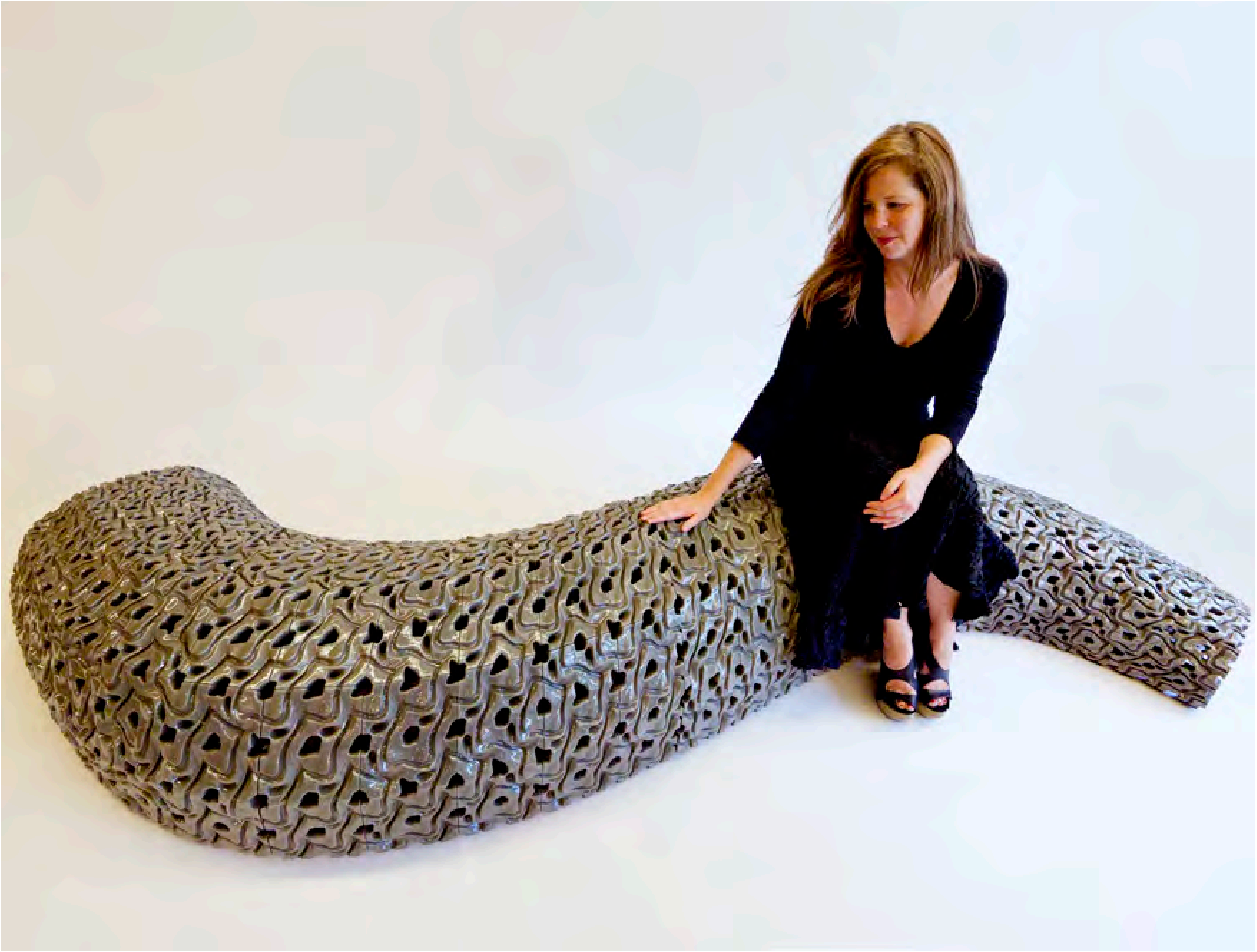


point distribution



base seat + point distribution for tiling





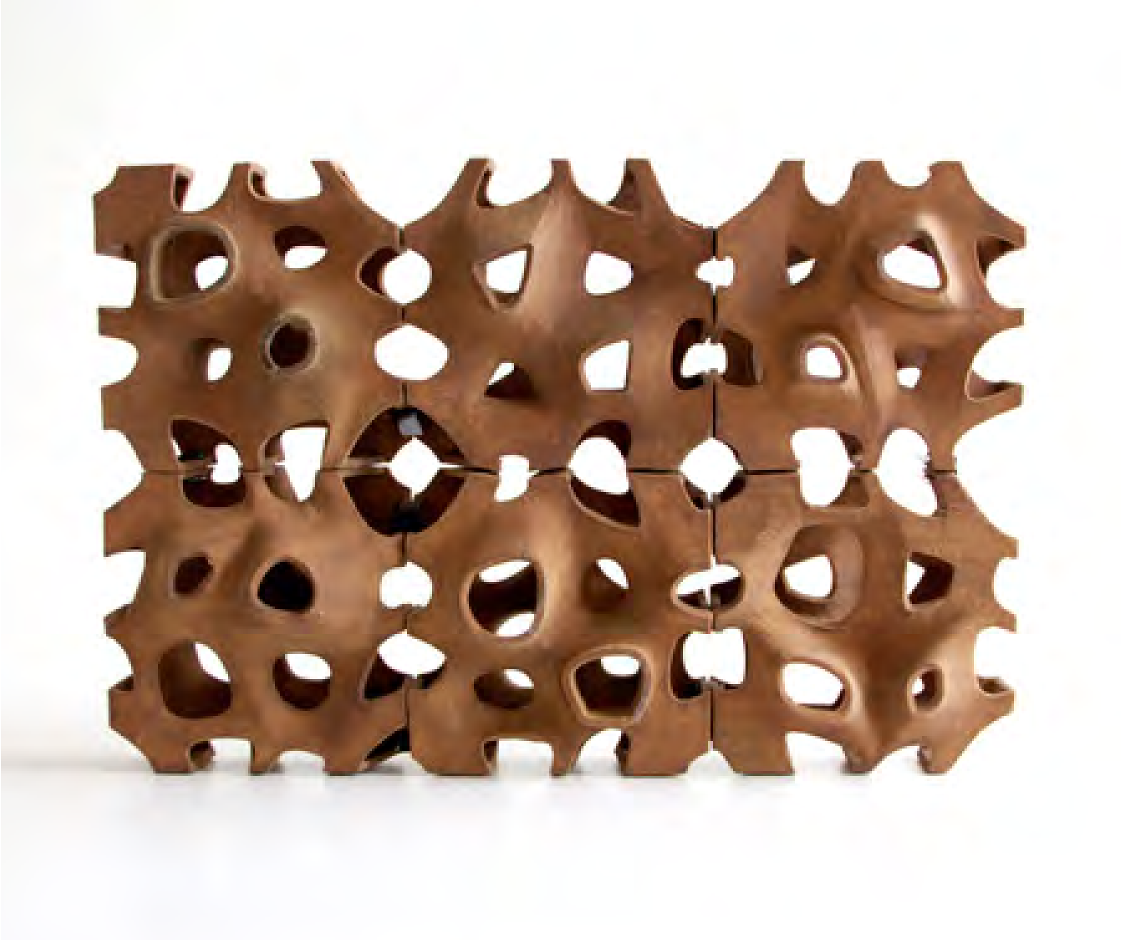
SAWDUST SCREEN

Project Date: FALL. 2013 / SPRING 2014
Project Team: Ronald Rael, Virginia San Fratello, Molly Wagner, Victoria Leroux

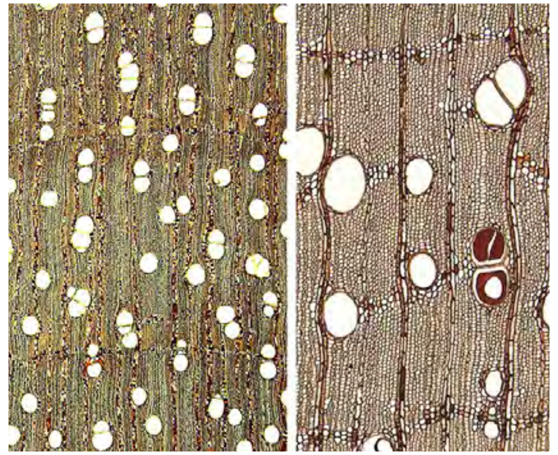
The Sawdust Screen is the outcome of research into the development of curtain wall and free standing structural wall systems using additive manufacturing technologies and wood-based materials. The Sawdust Screen is fabricated from 3D printed walnut and the surface retains the layering effect from the additive manufacturing process, which simulates natural wood grain. The screen is comprised of individual 3D printed wood components which are affixed together to form a variably dimensional enclosure and surface.

The Sawdust Screen is inspired by the vessels found in the microscopic analysis of wood anatomy in hardwoods. When viewed from the endgrain, vessels simply appear to be holes in the wood—what are commonly referred to as pores. In a live tree, vessels serve as the pipelines within the trunk, transporting sap within the tree.

In the Sawdust Screen, the vessels serve as an opportunity for visual porosity. The subtle curvature of each vessel accentuates the openings as convex or concave aperatures making the screen both a visual and haptic experience.

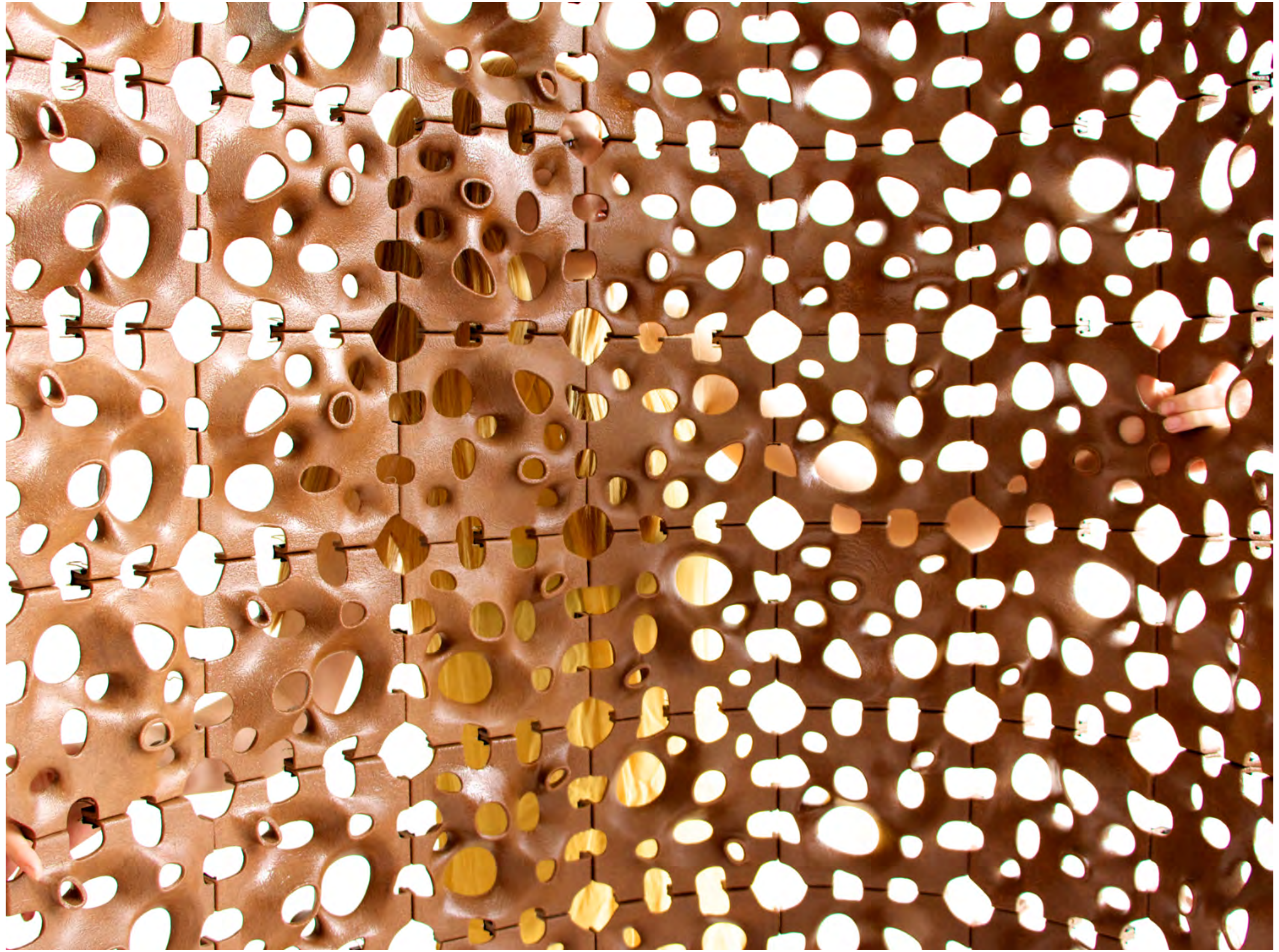


a double sided version of the screen



Pterocarpus santalinus. L Cross Section

close up showing scale of openings



PICOROCO WALL IN ORANGE

Project Date: Nov. 2014

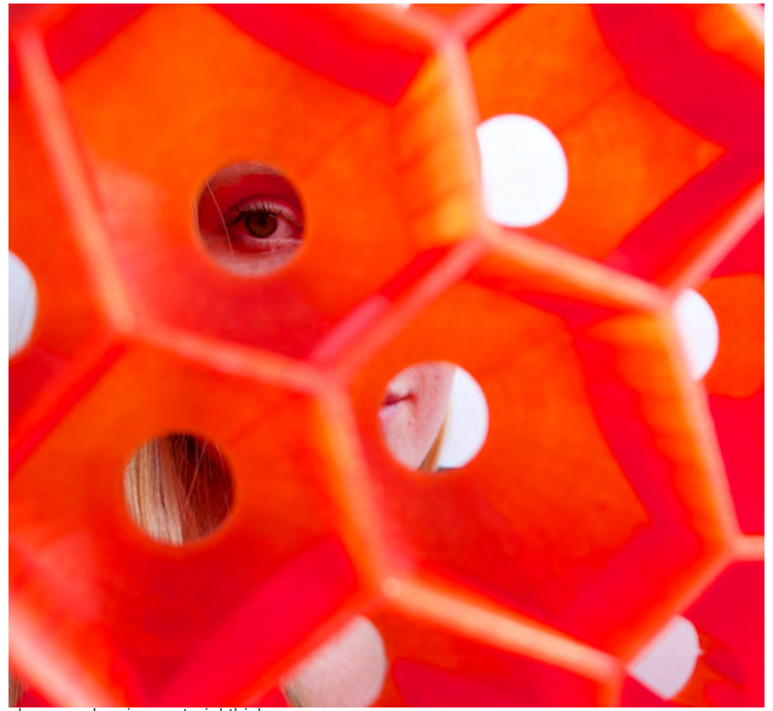
Project Team: Ronald Rael, Virginia San Fratello. Seong Koo Lee

The Picoroco Wall is constructed using the Picoroco Block™, a modular 3D printed building block for wall fabrication printed in PLA. PLA, or polyactic acid, is a thermoplastic aliphatic polyester derived from renewable resources. The wall is comprised of blocks with a dimension of 5.75″X5.75″X5.75″. Three different blocks are used in the construction of the wall—a 2, 3 and 4 hole block. Each block can be randomly rotated to create the variable pattern found in the wall.

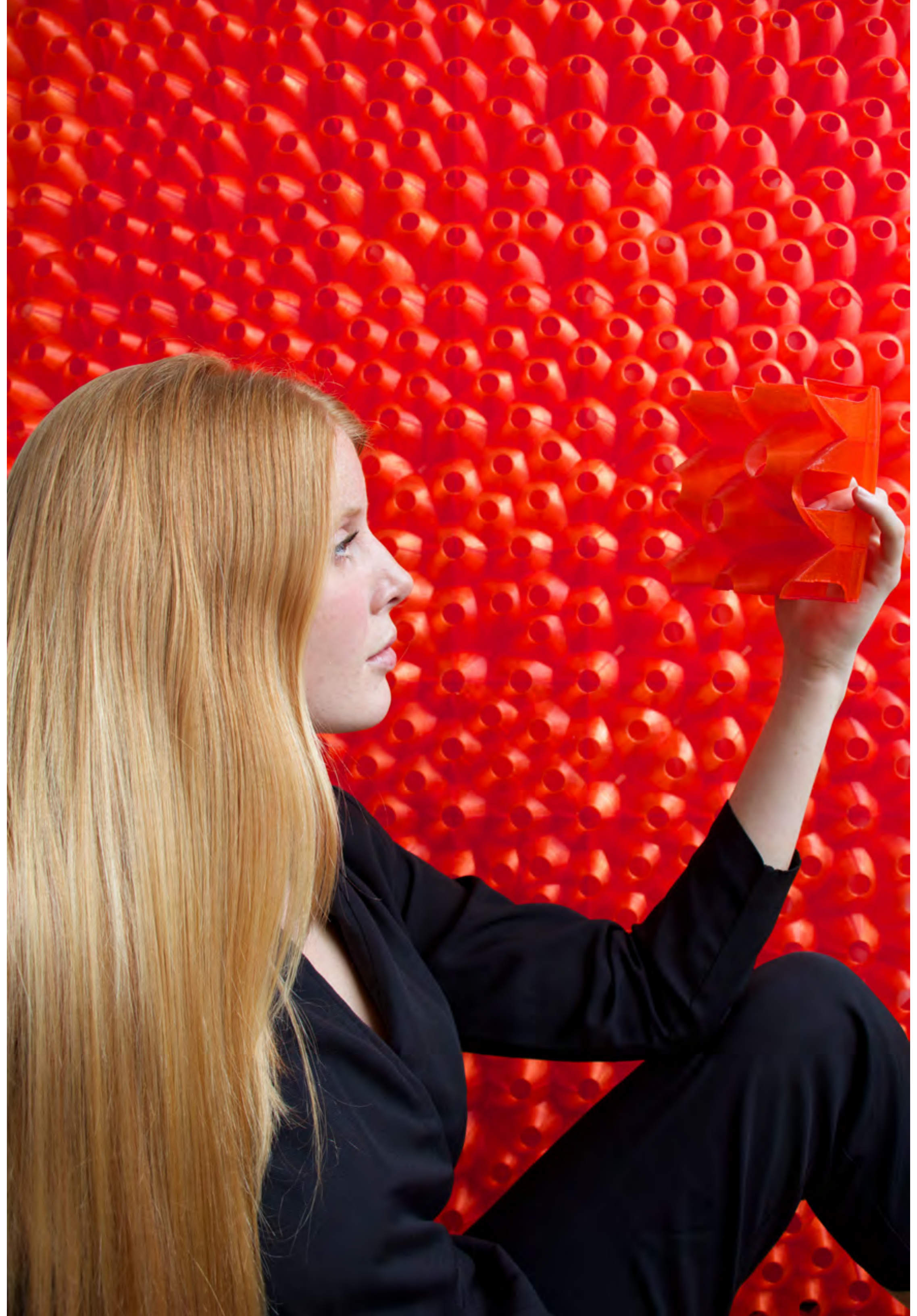
The transparency of the material creates different layers of visual porosity. Figures moving behind the wall are revealed within the cellular geometry of the blocks.

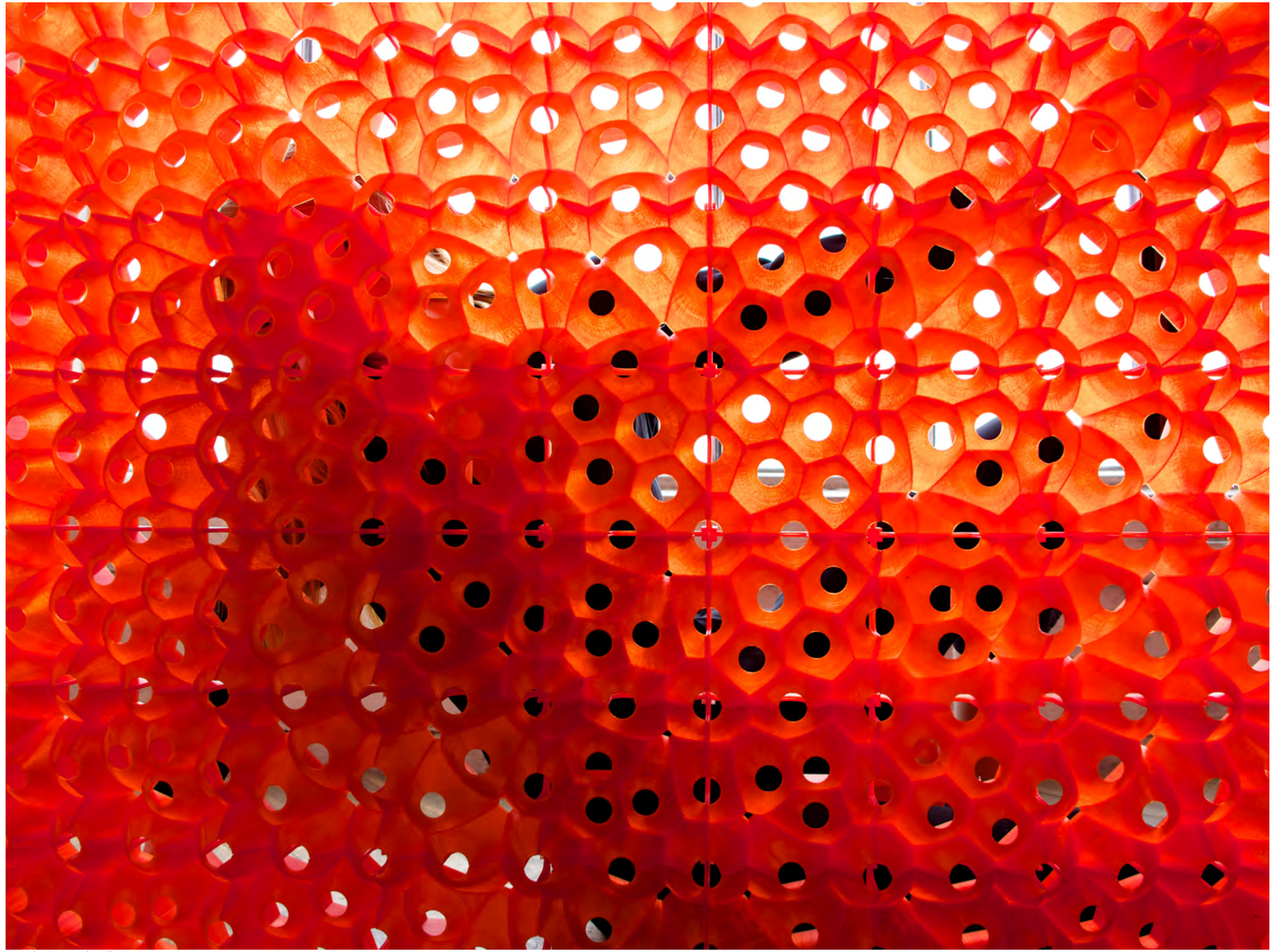
The opposing side of the wall reveals the bumpy surface's underlying geometry—a series of interconnected pentagons, hexagons and quadrilateral shapes whose terminus is a circle. Each block is connect by 3D printed clips of the same material that bind the corners of each block together making the wall easy to assemble and disassemble.

The variegated pattern allows for views to pass through in some areas of the wall, but not in others. The quality of light and shadow constantly changes across the surface with the passing of the day.



close up showing material thickness





translucency of wall

SALTYGLOO

Project Date: 2013
Project Team: Ronald Rael, Virginia San Fratello, Seong Koo Lee, Eleftheria Stavridi

The Saltygloo is an experiment in 3-D printing using locally harvested salt from the San Francisco Bay to produce a large-scale, lightweight, additive manufactured structures.

The Saltygloo takes its clues from the Inuit Igloo, both in form and concept. In the landscape of the San Francisco Bay Area natural power from the sun and wind, produce 500000 tonnes of sea salt each year. The salt is harvested from 109-year-old salt crystallization ponds in Redwood City. These ponds are the final stop in a five-year salt-making process that involves moving bay water through a series of evaporation ponds. In these ponds the highly saline water completes evaporation, leaving 8-12 inches of solid crystallized salt that is then harvested for industrial use. From this landscape, Rael and San Fratello theorize a new kind of architecture created through the lens of 3D printing and computer-aided design. The Saltygloo is made of a combination of salt harvested from the San Francisco Bay and glue, a “salty glue”, which makes an ideal 3D printing material, one that is strong, lightweight, translucent and inexpensive.

To build the Saltygloo, 336 translucent panels were 3D printed using this unique material invention. Each panel recalls the crystalline form of salt and is randomly rotated and aggregated to create a larger structure where all tiles in the structure are unique. The form of the Saltygloo is drawn from the forms found in the Inuit Igloos, but also the shapes and forms of tools and equipment found in the ancient process of boiling brine.

The panels are connected together to form a rigid shell that is further supported with lightweight aluminum rods flexed in tension, making the structure extremely lightweight and able to be easily transported assembled in only a few hours.

The translucent qualities of the material, a product of the fabrication process and the natural properties of salt, allow for natural light to permeate the space and highlight the assembly and structure and reveal the unique qualities of one of humankind’s most essential minerals.

The Saltygloo is on display at the Museum of Craft and Design in San Francisco as part of the New West Coast Design Exhibit.

boiling brine

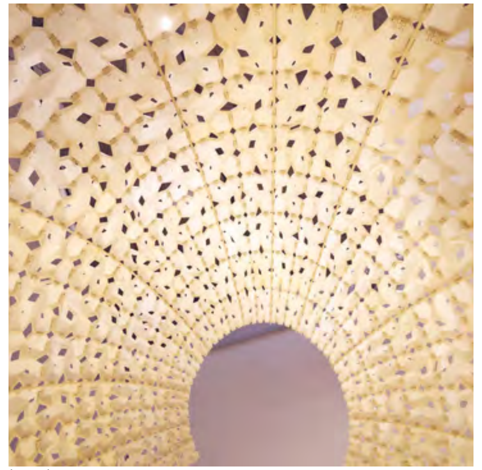
crystallizer in Redwood City

SALT-Y-GLOO under construction

Construction in the studio

Single tile

Interior view



Interior

Single salt tile

SALT-Y-GLOO at the Museum of Craft and Design

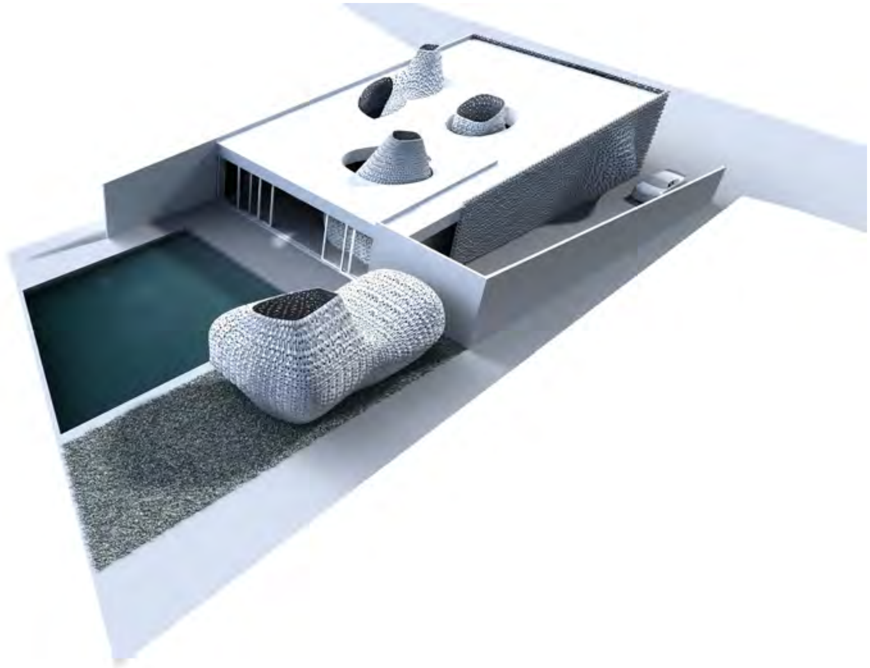
YINSHUA DASHA / 3-D PRINTED HOUSE

Project Date: May 2013-October 2013
Project Team: Ronald Rael, Virginia San Fratello, Seong Koo Lee, Eleftheria Stavridi

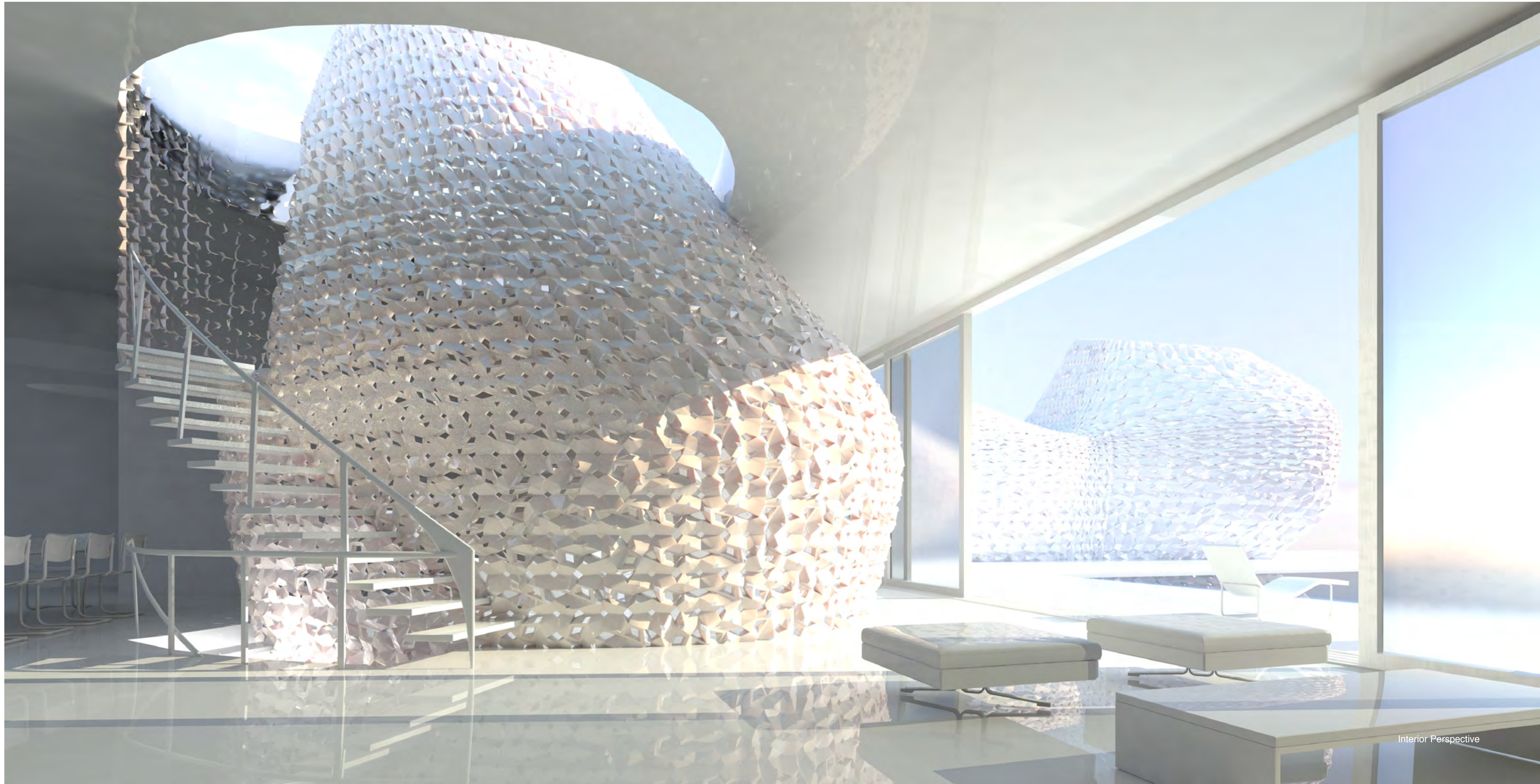
The Yìnshua Dàshà is a case study in 3D printing major components of a house. The exterior walls of the Yìnshua Dàshà will be constructed of concrete, pastered white, with portions of the exterior cladding that are 3D printed using a black foundry sand. Inside, the private spaces of the house—the bedrooms, bathrooms and family dining room are housed in translucent 3D printed double hieght and two story tall vessels constructed of salt. Outside, adjacent to the pool, is a free standing 3D printed pool cabana.

The house explores justopositions between traditional construction methods and 3D printed manufacturing. It also explores relationships between public and private within the organization of the program of the house.

Tranlucency, porosity and openness are all tested in the different material conditions and inform the optics, lighting, views and thresholds between adjacent spaces.

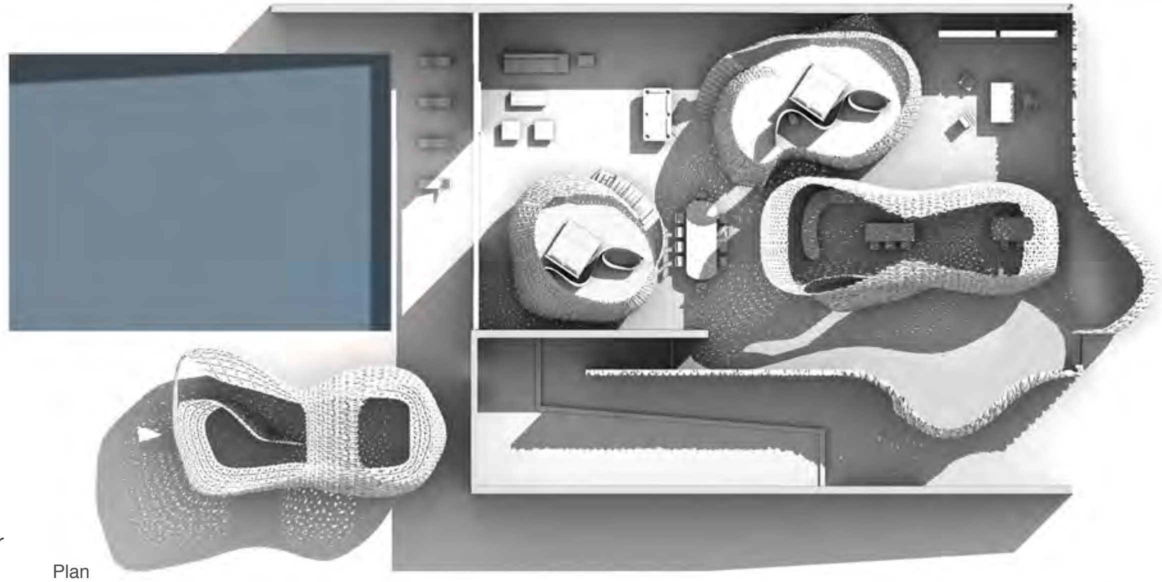


Site Plan



Interior Perspective

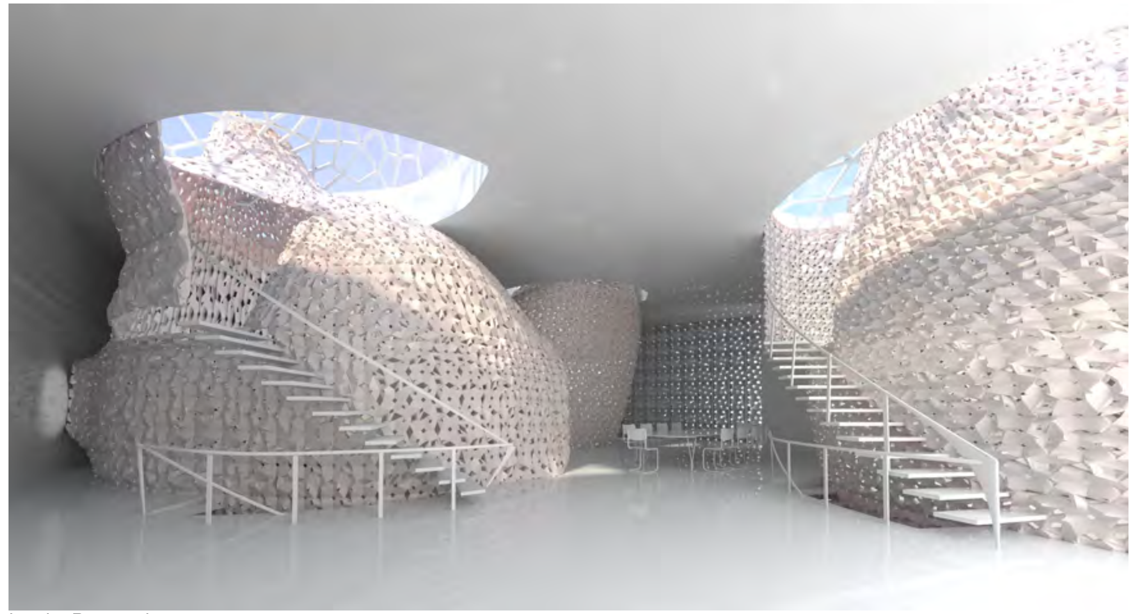
Section



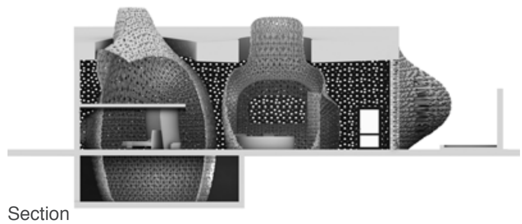
Plan

The Salt-Y-Gloo acts as a prototype for the interior volumes within the 3D printed house. Material development, manufacturing techniques, fabrication assemblies and material effects have been explored through the prototype and found to have desirable results for use in the interior of the house.

Photograph of 3D printed interior



Interior Perspective



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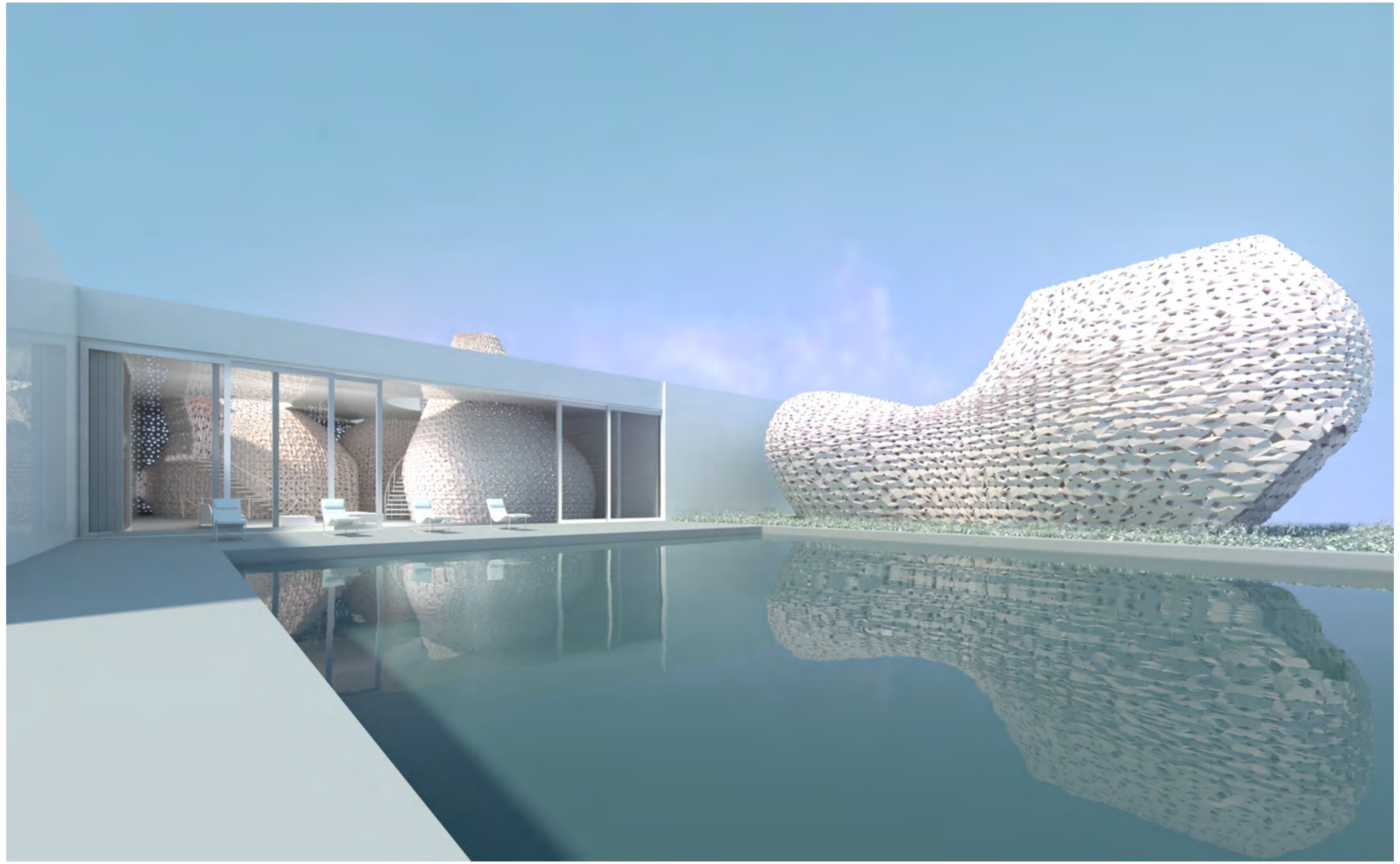
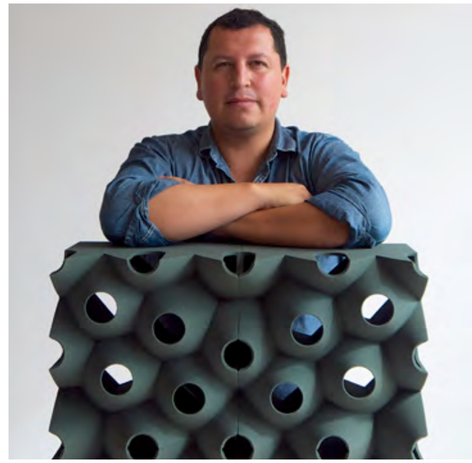
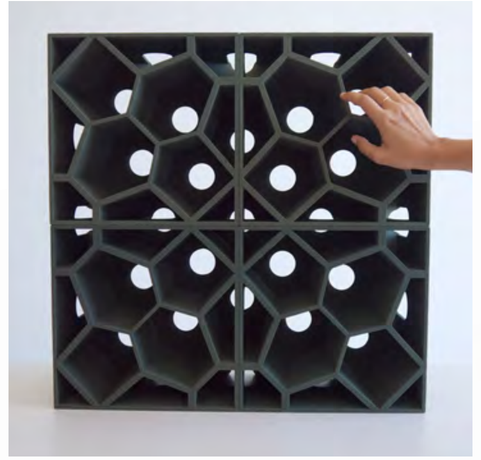
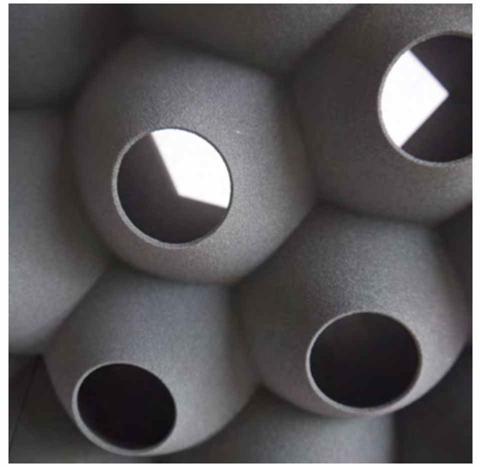


Exterior View

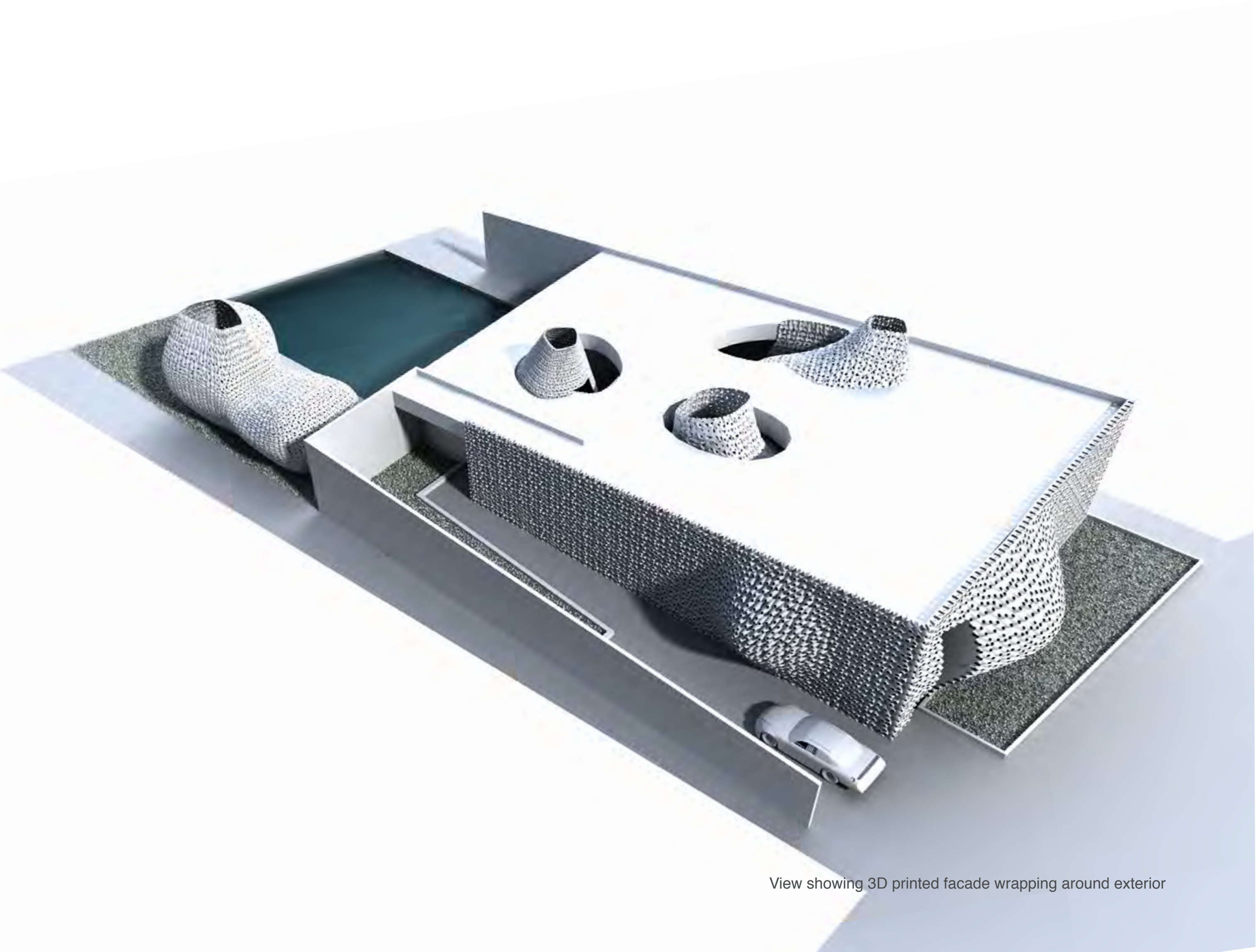




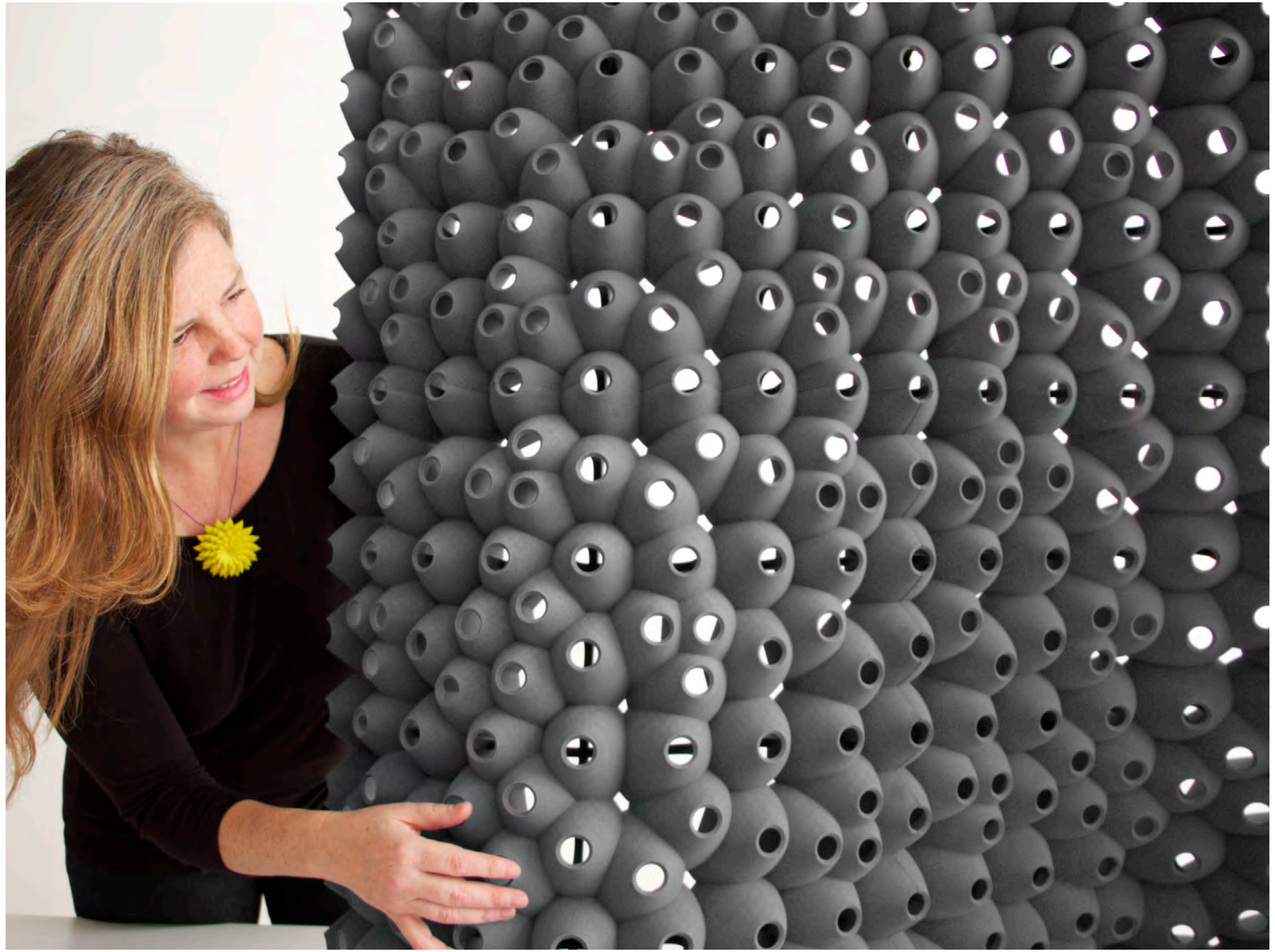
Interior side of 3D printed block



Close-up of PicoRoco Block used on exterior cladding



View showing 3D printed facade wrapping around exterior



3D printed prototype of building facade

SOL GROTTO

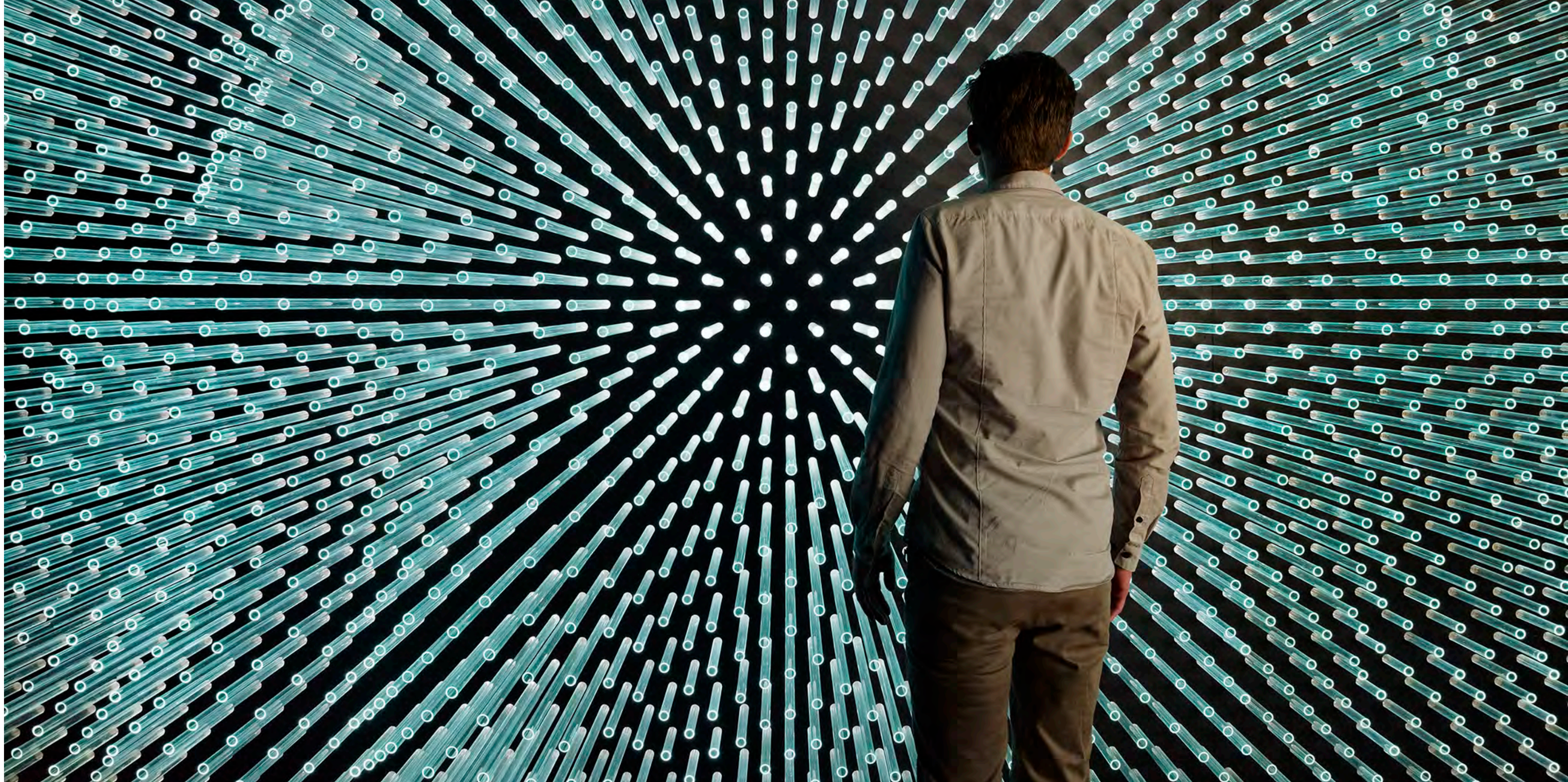
Project Date: 2012
Project Team: Ronald Rael, Virginia San Fratello, Bryan Allen, Chase Lunt, Dustin Moon, Kent Wilson, Bridget Basham

SOL Grotto is a spartan retreat—a space of solitude and close to nature where one is presented with a mediated experience of water, coolness and light . The SOL Grotto also explores Solyndra's role as a company Sh*t Out of Luck. 1,368 of the 24 million high tech glass tubes destined to be destroyed as a casualty of their bankruptcy, are used in the installation.

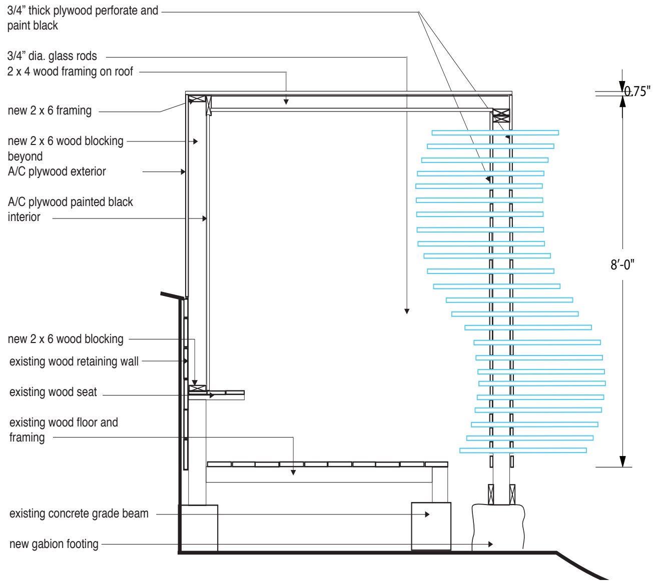
The project is located in the Berkeley Botanical Garden alongside Strawberry Creek in the California Native section as part of the exhibit Natural Discourse, which is a collaborative project between The University of California Botanical Garden at Berkeley and a multi-disciplinary group of artists, writers, architects and researchers who have been invited to spend time in the Garden's extraordinary collection of plants, engage with the horticulturists and develop new site specific work.

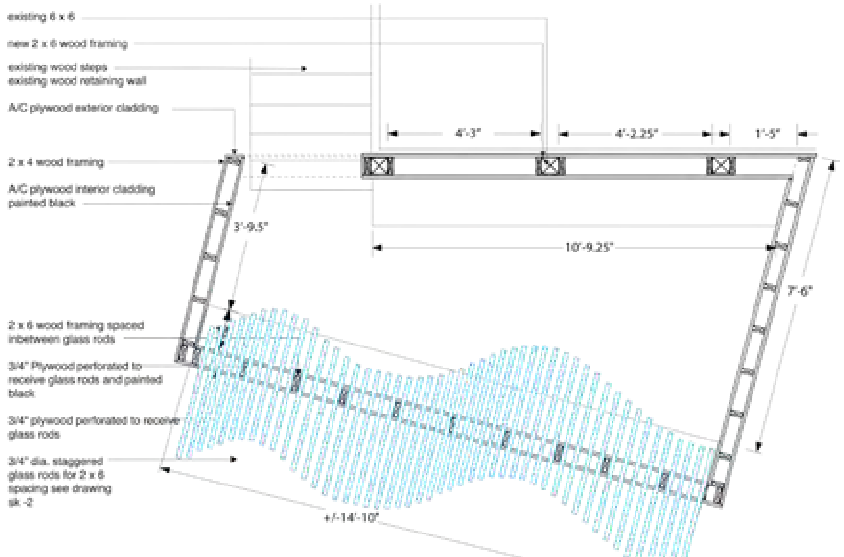
The tube's original role as a light concentrating element is extended to transmit cool air into the space via the Venturi effect, to amplify sounds from the adjacent waterfall via the vibrations of the tubes cantilevering over the creek, and to create distorted views of the garden.

The glass tubes are illuminated electric-blue naturally from the direct and ambient light that is conducted through the glass causing each tube to change in intensity throughout the day. Collectively, the tubes take on the form of a cave wall or a waterfall, evoking Plato's Allegory of the Cave where shadows, light and sounds call reality into question. The view through the rods is simultaneously kaleidoscopic and mesmeric and has become home to several insects found in the garden. The sound of a waterfall is present inside The SOL Grotto and the combination of sound, light, views and coolness filtering through the cracks in the flooring creates a highly sensorial space.



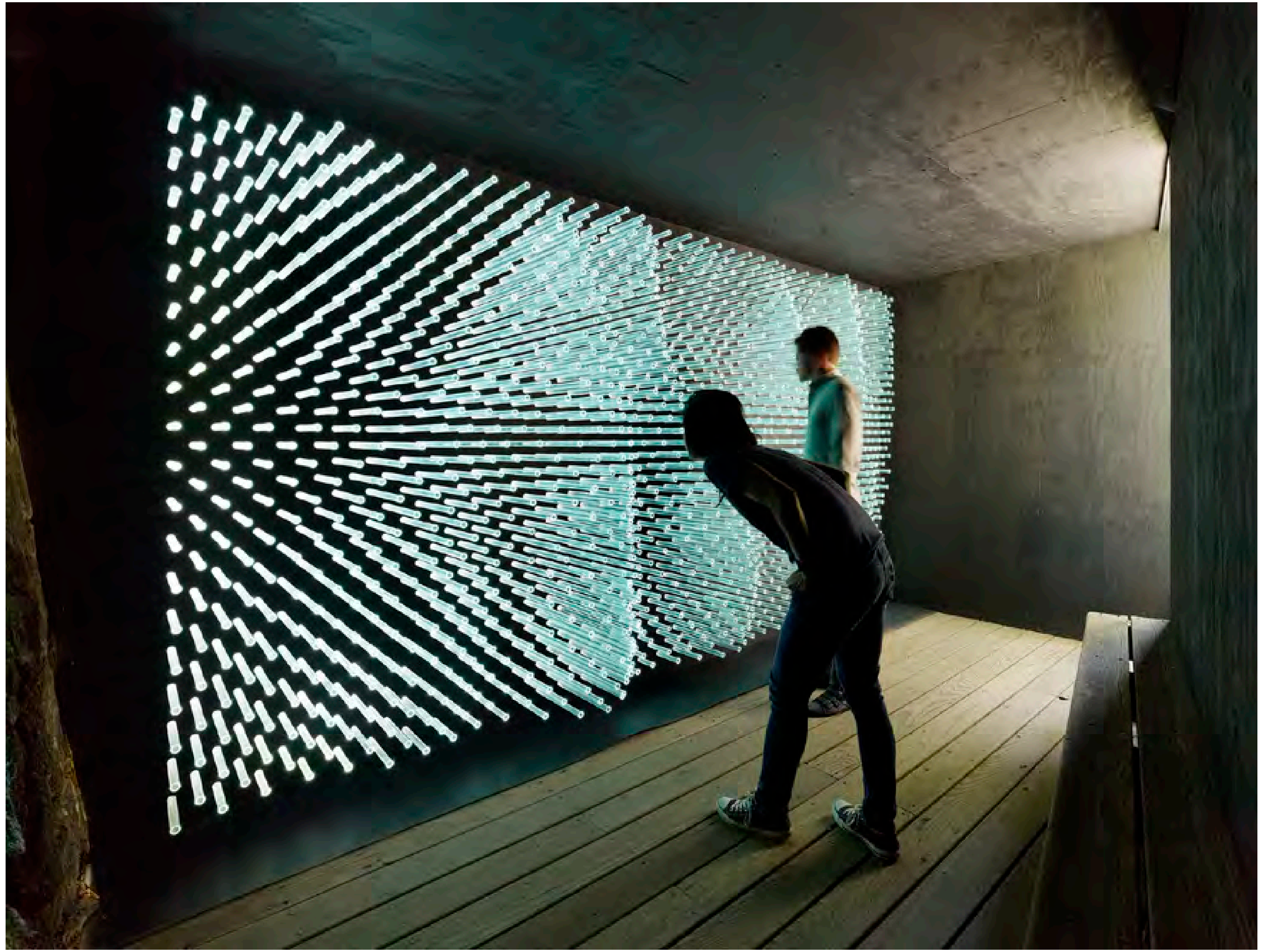
right: elevational view of SOLYNDRA tubes

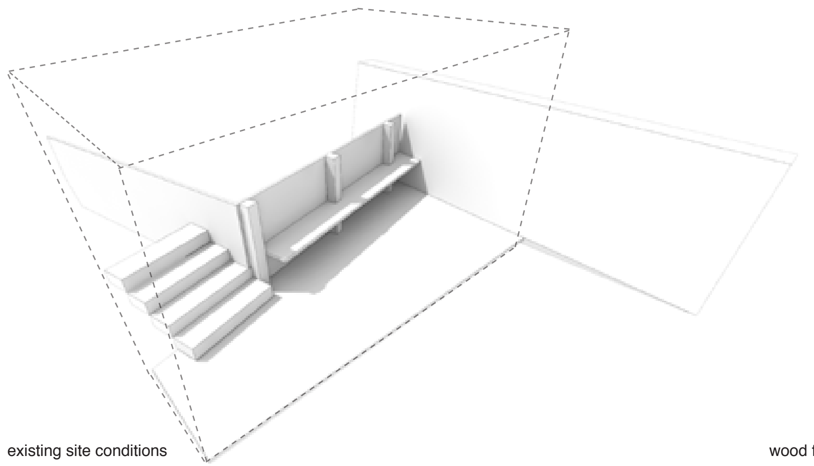




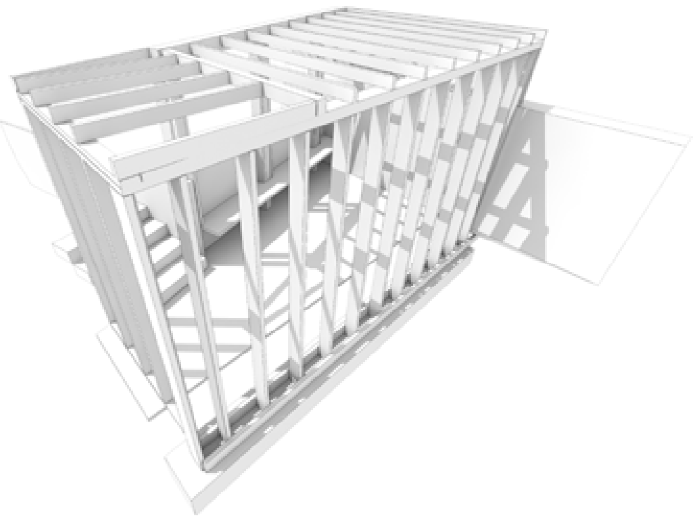
left: visitor looking through the tubes to the garden
right: interior of the SOL Grotto

plan and section

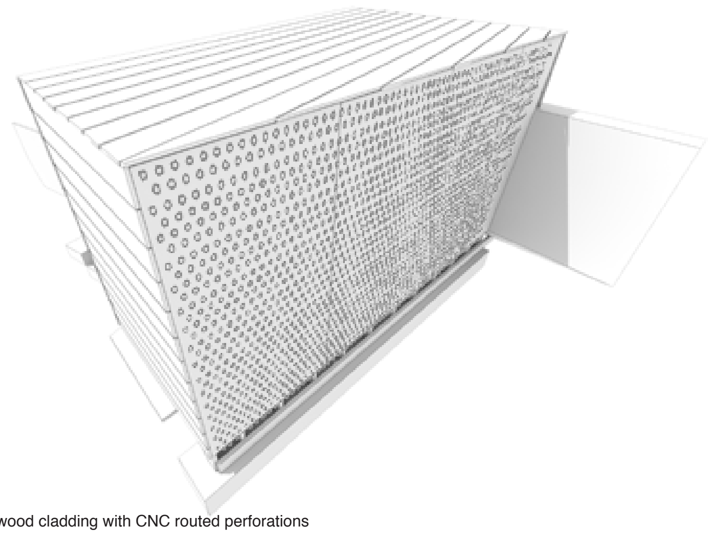




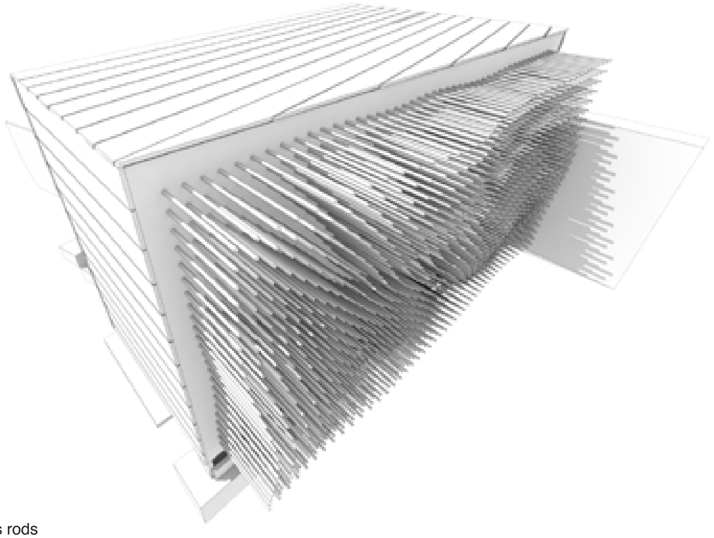
existing site conditions



wood frame

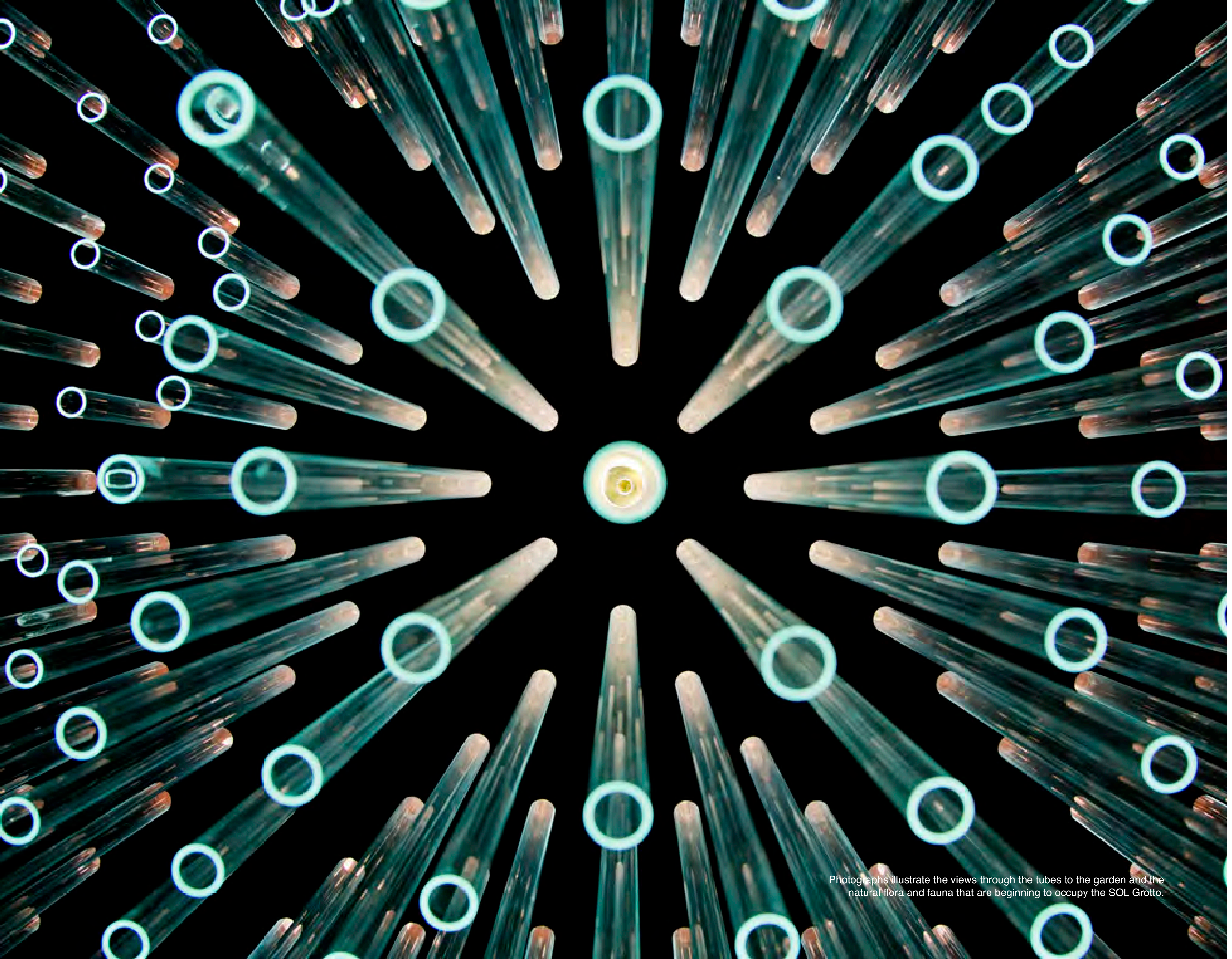


wood cladding with CNC routed perforations

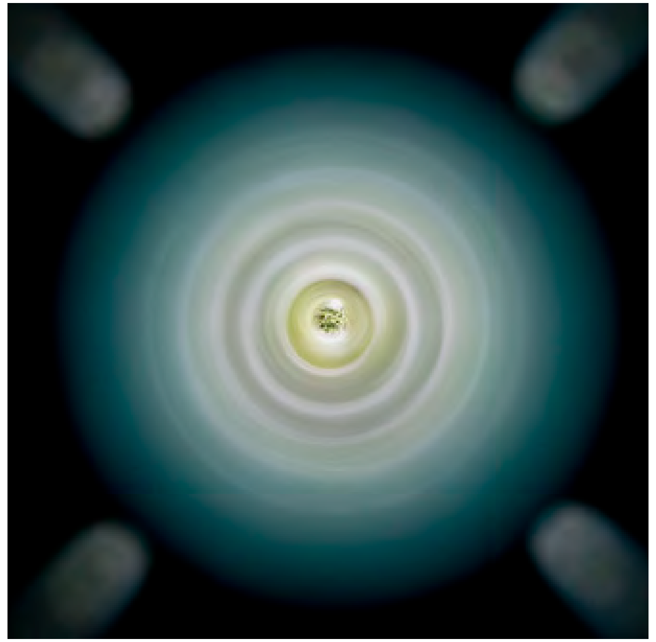


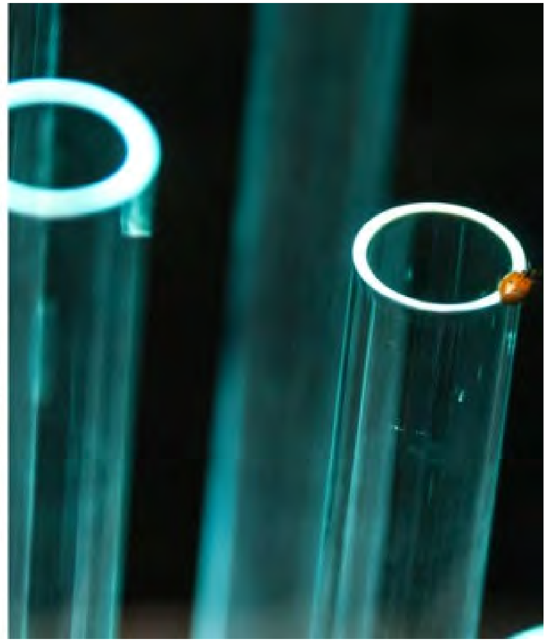
SOLYNDRA glass rods

right: SOL Grotto in the Botanical Gardens at dusk



Photographs illustrate the views through the tubes to the garden and the natural flora and fauna that are beginning to occupy the SOL Grotto.





STRAW GALLERY

Project Date: 2011
Project Team: Ronald Rael, Virginia San Fratello

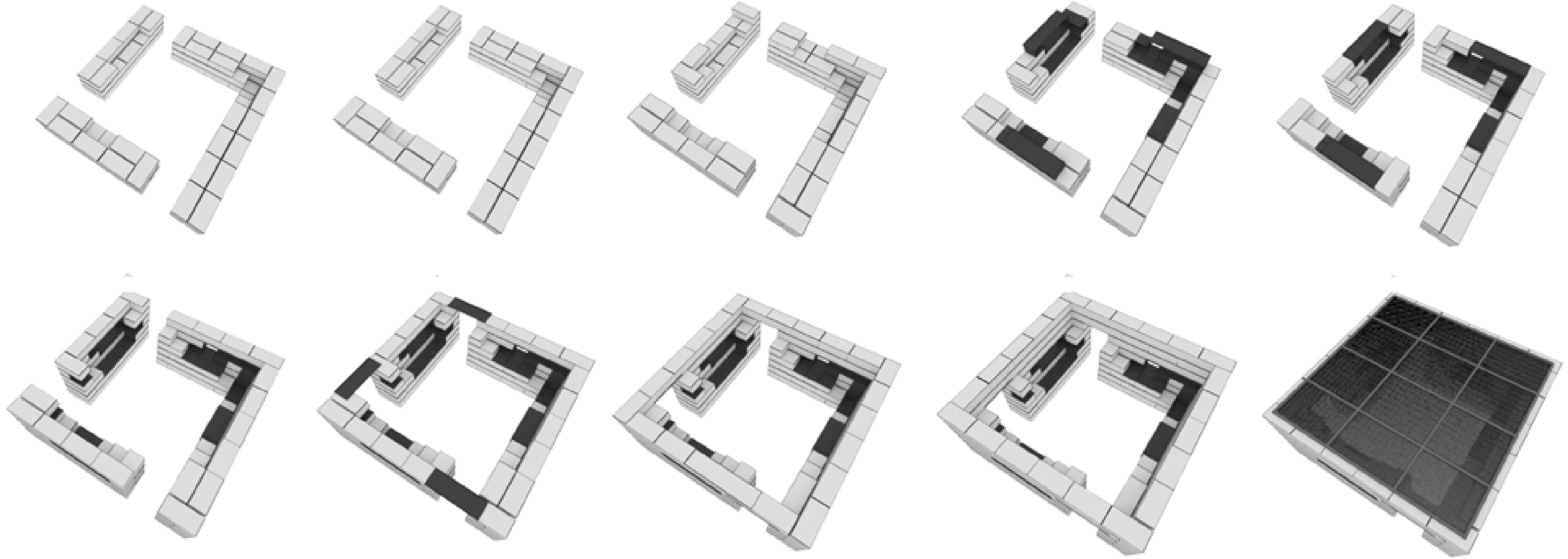
The Straw Gallery was designed for HEDGE Gallery for the 4th annual sf20/21 San Francisco Art and Design Show held at the Festival Pavillion, Fort Mason Center. The temporary gallery was on display from September 15th through 18th opening with a benefit for the San Francisco Museum of Modern Art's educational programs.

The gallery is an aromatic, enveloping, and raw space in contrast to the refined and modern elements that are displayed within. The gallery consists of three unfinished, blackened steel display niches interwoven within the walls of straw bales. Each niche is an excavation that is filled with HEDGE's highly edited visions of 20th and 21st century design, art and craft, presented at different levels relative to the eye and the hand of the visitor.

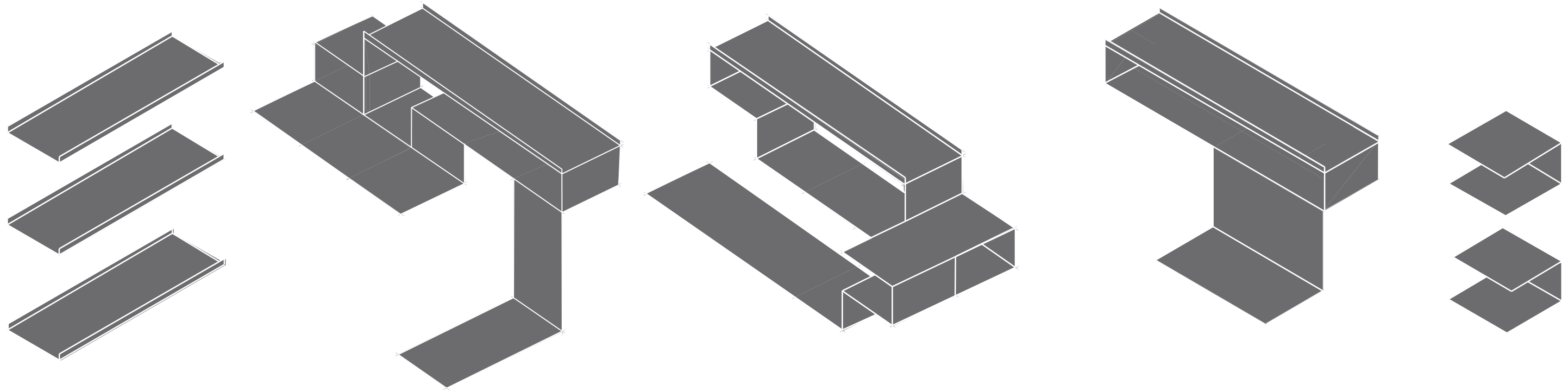
The juxtaposition of the two materials, steel and straw—one industrial and the other representing a storied agrarian history—heightens the tactile sensibilities as one navigates between the richness of the hay and the clean surfaces of the steel compartments. Straw is an incredibly effective acoustic buffer and the walls are in most places two bales thick and placed strategically to block views to the exterior as you enter the space. The experience within Straw Gallery is one of quiet, calm and focused observation in contrast to a busy exterior.

The several hundred wheat straw bales, an agricultural by-product used for bedding, roughage and fuel, used to construct the gallery were returned to the feed store. The steel shelves were recycled and will be used to construct furniture and shelving in San Francisco.

above: ceiling perspective and floorplan right: view from the exterior



above: stacking sequence
right: elevational view of straw gallery in site



above:steel shelves
below: details of steel inserted into the straw
right: view of the interior showing the display of objects on straw and steel shelves

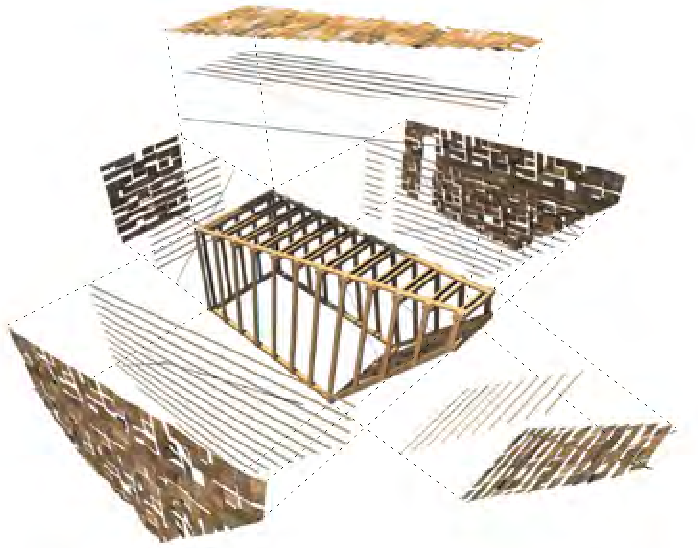
HOMELESS HOUSE: Sukkah of the Signs

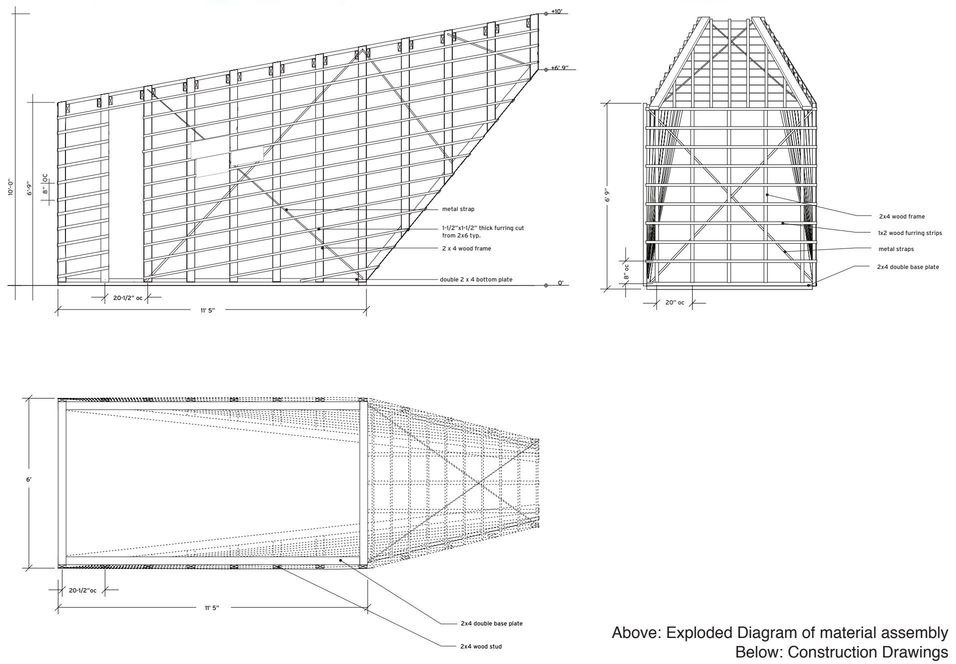
Project Date: 2010
Project Team: Ronald Rael, Virginia San Fratello, Maricela Chan, Emily Licht

Ten years ago, architects Ronald Rael and Virginia San Fratello started buying cardboard signs off homeless people in and around their Oakland-based firm. The idea was to exhibit the signs as works of art, then sell them to raise money for charities that benefit the homeless. But the project stalled, leaving Rael and San Fratello waiting for an opportunity to resurrect them from storage. That came this year, with the announcement of Sukkah City: NYC 2010, a new, international design competition challenging architects to re-imagine the ephemeral, elemental shelter known as the sukkah.

Sukkah City is the brainchild of Joshua Foer, a journalist, author and member of Reboot, a New York-based nonprofit that encourages creative Jews to "reboot" Jewish traditions and make them relevant again in modern life. Reboot co-founder Roger Bennett was Foer's partner in this endeavor. The project also received support from the Union Square Partnership, an organization that works to enhance the atmosphere of New York City's Union Square. "We wanted architects to think about the sukkah in a way that was experimental and contemporary," Foer said, "and show what kind of creative possibilities can lie within the constraints of Jewish law."

The contest attracted nearly 600 entries from 43 different countries, including Kazakhstan, Bulgaria, Thailand and Paraguay. Rael and San Fratello, whose East Bay firm combines architecture, art, culture and environment, created the "Sukkah of the Signs," a wooden structure clad with signs — some as small as a sheet of paper, some large enough to be a makeshift bed — made by the homeless and destitute.





Above: Exploded Diagram of material assembly
Below: Construction Drawings

“This project reinforced something for us as architects,” said Rael, a professor at U.C. Berkeley. “Our designs can send a social and political message, which is often hard to deliver. Clients don’t hire you to make social commentary, but we had the chance to express that through our work.” Inspired by a mosque made entirely of cardboard that Rael and San Fratello discovered in a Yemenite refugee camp a few years ago, the “Sukkah of the Signs” boasted roughly 280 signs, covering a 10-foot wooden structure of lumber pieces. The signs came from throughout the Bay Area, mostly in San Francisco. Rael and San Fratello drove down Van Ness, stopped at freeway exits and wandered through the Haight District. Sign bearers led them to others in Golden Gate Park. Rael even put an ad on Craigslist to get more.

“You see these guys on the streets all the time brandishing these signs,” Rael said. “We thought they were amazing and beautiful works of art.” Convincing the homeless of that took some time. Rael remembered how awkward it was initially approaching their subjects to ask for their signs — in many cases, it was all they had. He gradually learned that listening to their stories, coupled with an offer to buy the sign for a couple bucks, usually translated to success. Rael met people of all ages, races and religious backgrounds. They clutched signs that were humorous, serious, thought provoking and strange. One woman held a sign that said: “Need money for a new pair of shoes.” She didn’t have legs.

He approached people who couldn’t talk or write, grasping signs that made no sense as an act of desperation. In the bowels of

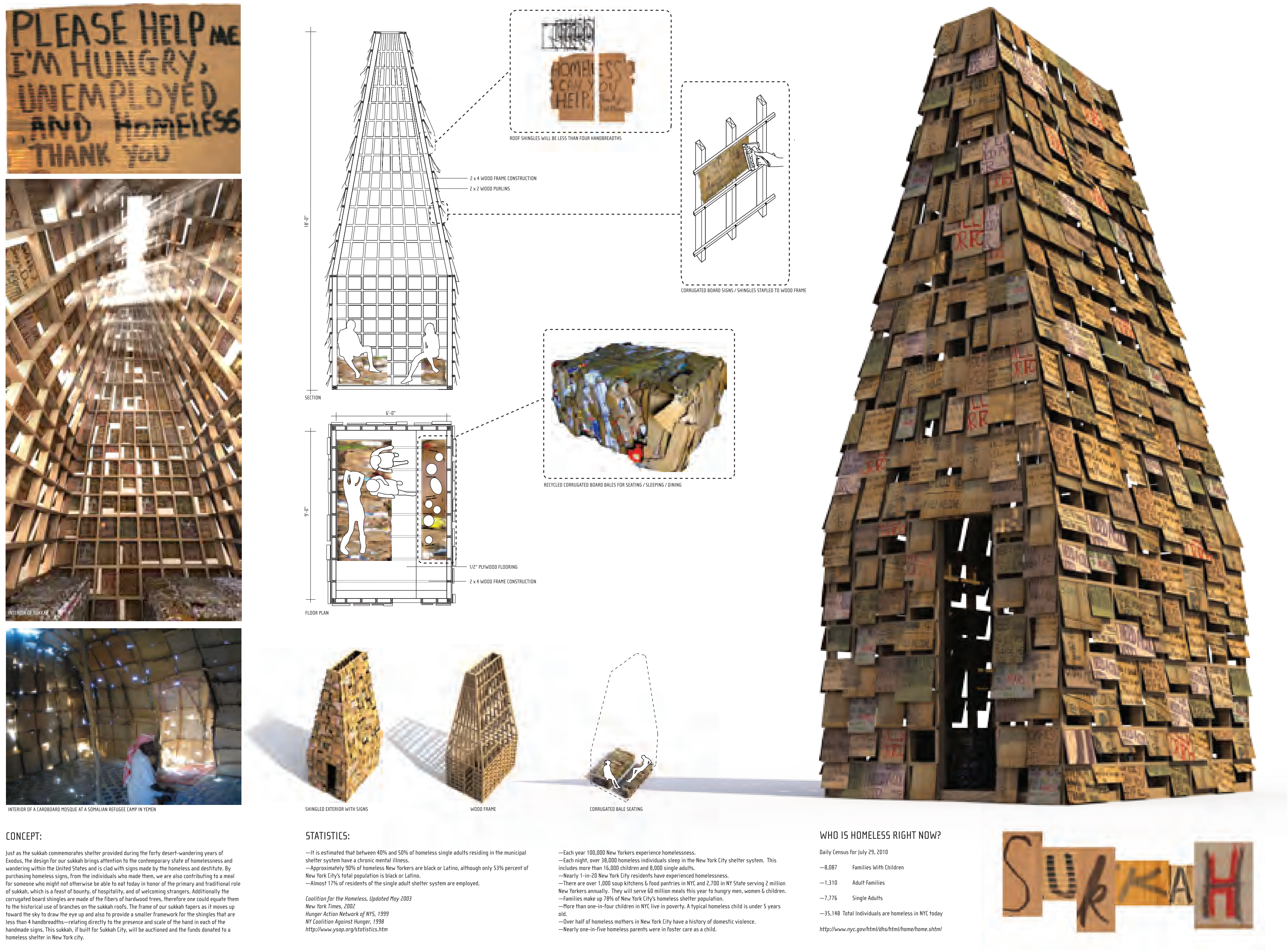
Examples of signs collected from San Francisco, Oakland, San Jose, San Diego, Los Angles, Venice, Las Vegas and Denver

Above: People who contributed their sign to the project
Below: Homeless man in Union Square Park in front of Sukkah of the Signs

Golden Gate Park, he talked to individuals who lost their jobs and couldn't make rent, stuck in a vicious cycle they could not escape. "I was already empathetic toward people on the streets," Rael said. "To a greater extent, I understand the reasons of why they are there. Some accuse [the homeless] of being lazy or wanting to be on the streets, but so many have no choice."

Creating the "Sukkah of the Signs" inspired Rael and San Fratello to start the Homeless House Project, whose aim is to bring attention to homelessness in America. Rael hopes to publish a book with images of the signs used in the sukkah. "When we learned about the concept of the sukkah, it was a nice way to think about the contemporary issues of homelessness in the U.S. and the interesting stigmas that arise," Rael said. "In a sense we were waiting for a project like Sukkah City. We had the signs and it was a good opportunity to marry the two projects."

Erected for one week each fall during the festival of Sukkot, the sukkah is traditionally a space for sharing meals, entertaining, sleeping and rejoicing. Its construction must adhere to precise parameters: the structure must be temporary, have at least two and a half walls, be big enough to fit a table, and have a roof made of shade-providing organic material through which one can gaze at the stars. "We've inherited this tradition of sukkah building, but very few of us know the real rules or even build them anymore," said Reboot Executive Director Lou Cove. "For those who do it's very nice, but it's not a widely shared creative enterprise. The idea of making the sukkah an architectural piece was a way of reinvigorating that tradition." While the sukkah's religious function is to commemorate the temporary structures



in which the Israelites dwelled during their exodus from Egypt, it is also a symbol of the transience of life as expressed in architecture.

Contestants did not have to be Jewish. The teams behind the 12 finalists received guidance from Judaic experts on how to craft a kosher sukkah. Neither Rael nor San Fratello are Jewish, but that didn't matter. "At this point, I think I'm much more familiar with the rules of constructing a sukkah than a lot of Jews," Rael said with a laugh. "Learning about lesser-known traditions of Judaism was really interesting." From dawn until dusk Sept. 19 to 20, nearly 200,000 passers-by wandered through Sukkah City in Union Square Park to marvel the sukkahs. "It turns out that architects viewed Jewish law in a way we could not anticipate," Foer said. "Working with the design constraints handed down for thousands of years was inspiring. They immediately understood how many levels of residence there are in the sukkah — what it means to be impermanent or homeless, to the role it plays in reconnecting Jews with their agricultural past. "All that is bound up with esoteric rules, some of which are playful," he continued, noting that a sukkah may be built out of an elephant's skeleton but no other animal's. "If that's not an invitation to do something weird, then I don't know what is."

Exerpted fro the article, "A booth with a view: Oakland architects build sukkah using signs from the homeless" by Amanda Pazornik. J! Weekly, Thursday, September 23, 2010.

Photo: Nate Levy
Sukkah City, NY

PRADA MARFA

Project Date: 2008
Project Team: Ronald Rael, Virginia San Fratello

On July 13, 2005, 22 miles north of the U.S./Mexico border, patrol agents from the Marfa Sector of the United States Border Patrol surrounded five people traveling through the Chihuahua Desert in West Texas. Suspecting illegal activity, the agents had been informed that illegal immigrants were detected by the tethered aerostat radar system hovering overhead that provides counter-narcotics and border crossing surveillance and can distinguish targets down to a meter across at ground level.

It is not uncommon that coyotes, smugglers involved in the profession of human trafficking, drive the desolate roads searching for "wets", the derogatory term for illegal immigrants, in the vast desert expanse surrounding Marfa. When the five suspects were questioned on the nature of their business the answer was not so clearly comprehended by the Border Patrol. The suspects were a gallery curator, a photographer, an artist, and two architects who were discussing the selection of the future building site of Prada Marfa, a minimalist sculpture that replicates the luxury boutique where the Fall 2005 line of Prada shoes and bags were to be displayed.

The juxtapositions between the United States and Mexico, or between wealth and poverty, that are clearly evident in the Big Bend region of Texas define a landscape charged with contrasting conditions in which Prada Marfa is built. The immense ranches that comprise the area, each several thousand acres or larger, often appearto be abandoned, but are owned by many of the wealthiest people in the United States. Most of the ranch owners have ties to oil, and more recently, dot com wealth, including a ranch owned by Amazon.com CEO and founder Jeff Bezos, where he has announced plans to construct a spaceport just down the road from Prada Marfa. Just as each of these polarities are somehow equally at home and "foreign" to this environment, so to is Prada Marfa, with it's delicate interiors and massive walls, schizophrenically positioned in the geo-political and cultural framework in which it is built. In fact, the process of building the project is as simultaneously contextually grounded and extrinsic as the work itself.

The primary building material used to construct Prada Marfa is dirt. While it may seem odd to construct a building with soil, particularly one with the associated title Prada, building with earth is actually quite common. It is estimated that currently 1/2 of the world's population, more than 3 billion people on 6 continents, lives, works, or worships in buildings constructed of raw earth. This makes fragmental soil, not to be confused with other materials that come from the ground, such as stone, cement, or metals derived from ore, the most ubiquitous building material on the planet. Earth buildings can also be found in almost every climatic zone on the planet, from the deserts of Africa, Australia and the Americas to England, Denmark, China and the Himalayas.

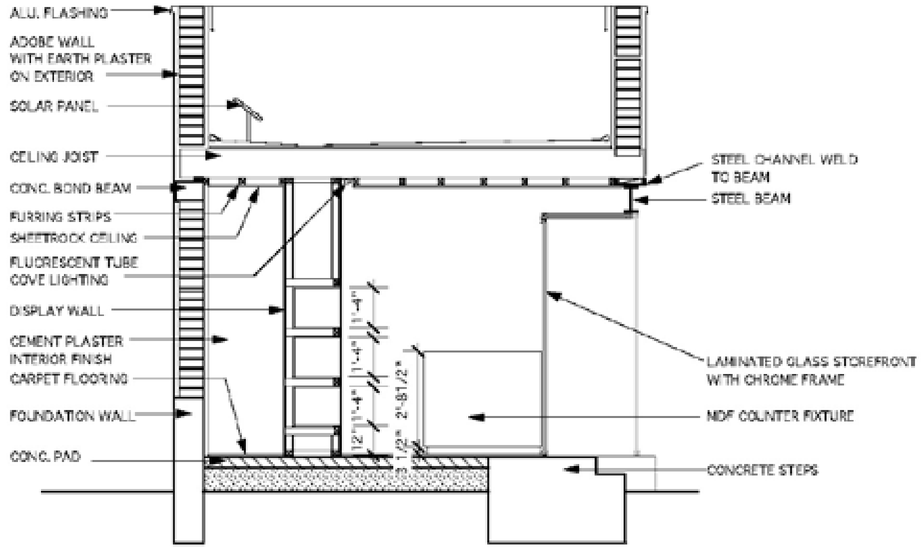
Whereas earth is a material that westerners commonly perceive to be reserved for the small, humble structures of developing countries, there are earth buildings of almost every architectural type in use by every economic and social class. Examples of churches, hospitals, museums, embassies, and even an airport demonstrate the wealth of earth building types found throughout the world. Typically, earth is also considered to be a building material only used in rural environments, but earth architecture can be found just as easily in contemporary urban environments. The world's first skyscrapers, 11 story buildings first constructed over 500 years ago, continue to be constructed entirely from mud in the dense cities of Yemen. Perceived as a material of low quality, earth buildings also represent the oldest extant buildings

right: Prada Marfa at dusk

on the planet. Using approximately 7,000,000 mud bricks, the Ziggurat at Ur dates back to 4000 B.C. Taos Pueblo constructed between 1000 and 1450 A.D., in New Mexico is the oldest continuously occupied dwelling in North America and was also constructed from raw earth.

While earthen architecture is often considered the building material of the very poor , many wealthy residents inhabit the vast mud brick suburbs of Santa Fe, New Mexico. Ronald Reagan's former Ranch House (also known as "The Western White House") in California, Saddam Hussein's childhood home in Iraq, and Chairman Mao's childhood home in China were all constructed of mud brick, which speaks to the great breadth of ideological extremes represented by this omnipresent material. Now we can add Prada Marfa to this "A-List" of earthen architecture – the first Prada related building constructed of mud.

A large percentage of buildings in the region surrounding Prada Marfa, are also traditionally constructed of mud brick. Often made directly from soil excavated from the build site, mud brick, called adobe in Texas, is a brick made from soil mixed with water and straw and left to dry and harden in the sun. Historically, this was the traditional construction method used by the Mexican and Mexican American population. In the case of Prada Marfa, the 2,500 mud bricks used to construct the building were made by machine and express shipped to the site from a mud brick yard in Alcalde, New Mexico, over 500 miles away. Not unlike the luxury goods that fill the faux-boutique, the mud bricks arriving from this adobe yard are primarily manufactured to supply a growing population of southwestern affluence enamored with the romantic notion of living in a house constructed of earth. Increasingly, the demands made by wealthy interstate immigrants longing for mud brick residences have had a dramatic effect on the cultural and built landscape.



left: adobe bricks and concrete mortar walls
right: 2005 collection of Prada shoes and purses

At one time, buildings made of earth were looked down upon, and ultimately made illegal to construct for several decades. Today, however, mud brick's increasing popularity has created a demand for the material that has transformed it into a status symbol in the southwestern United States. The humble earthen houses that comprise Marfa's residential district now fetch several hundred thousand dollars from New Yorkers, Houstonians and Los Angelenos. Thus, what was once a vernacular tradition has transformed into a capitalist driven process that often leaves the traditional descendants of earth dwellers unable to afford mud, forcing them to switch to an ironically more affordable consumption of prefabricated mobile homes and concrete-block houses. Much like the knockoffs of Prada bags that are a consequence of the high price tag of authentic Prada merchandise, adobe knockoffs, faux-adobes, are the preferred style of manufactured southwestern homes.

Unlike traditional mud brick buildings, whose bricks are laid in an earthen mortar, the mud bricks used to build Prada Marfa were set in a cement mortar. The juxtaposition between the industrial material of cement and the traditional mud brick could be read as a nod to Donald Judd, but the combination also represents the bipolar nature of the context in which it is built. In Marfa the use of industrially produced cement, introduced by the U.S. military

– each leaving built traces in the landscape that are evident today. By crossing a border between art as commodity and commodity as art, Prada Marfa offers a conceptual interpretation of the latest wave of occupation in the region - Judd and the gentry of gallery owners, artists and art lovers who are his followers. It also raises questions regarding the consequences of this history.

While Prada Marfa was not constructed with illegal labor, mud brick construction is labor intensive and labor provided by illegal aliens is cheap. The demand for inexpensive labor in America coupled with a search by immigrants for higher paying jobs work hand in hand to prompt people to cross the desert by foot. Although it is difficult to know exactly how many immigrants cross the border in the Marfa sector each year, in 2005 there were 10,536 illegal border-crossing apprehensions and approximately 12 migrant border-crossing deaths. Most of these deaths are attributed to heat stroke or hypothermia. From a distance, illegal aliens walking through the desert at night

might perceive the illuminated building to be a possible source of water or shelter. However, upon closer inspection, Prada Marfa reveals an irony that connects the history of the region while also offering a prognostication. It is not uncommon for one's shoes to wear out during the arduous journey across the desert. In a desperate attempt to protect tired feet from the rough terrain, immigrants are known to try to fashion shoes from the only material available – the yucca plants that dot the landscape. The contrastingly opulent presentation of meticulously organized shoes and bags housed within the familiarity of mud brick walls also foretells the future – a growing socio-economic polarity at a local and, indeed, global level. – From the essay "House of Prada / House of Mud", Prada Marfa Catalog, Ronald Raelimmigrants for higher paying jobs work hand in hand to prompt people to cross the desert by foot. Although it is difficult to know exactly how many immigrants cross the border in the Marfa sector each year, in 2005 there were 10,536 illegal border-crossing apprehensions and approximately 12 migrant border-crossing deaths. Most of these deaths are attributed to heat stroke or hypothermia. From a distance, illegal aliens walking through the desert at night might perceive the illuminated building to be a possible source of water or shelter. However, upon closer inspection, Prada Marfa reveals an irony that connects the history of the region while also offering a prognostication. It is not uncommon for one's shoes to wear out during the arduous journey across the desert. In a desperate attempt to protect tired feet from the rough terrain, immigrants are known to try to fashion shoes from the only material available – the yucca plants that dot the landscape. The contrastingly opulent presentation of meticulously organized shoes and bags housed within the familiarity of mud brick walls also foretells the future – a growing socio-economic polarity at a local and, indeed, global level. – From the essay "House of Prada / House of Mud", Prada Marfa Catalog, Ronald Rael

left: Boyd Elder visiting Prada Marfa

NOWHERE

Project Date: 2013
Project Team: Ronald Rael, Virginia San Fratello

The Museum of Nowhere is a remote frontier for art, design, craft and architecture. NOWHERE's aim is to recognize that in a century where greater than 50% of the population of the planet is migrating to cities, a rural community can also be a SOMEWHERE of rich cultural, geographic, historic and aesthetic importance. NOWHERE (or NOW HERE as the locals like to say) demonstrates this by combining the work of internationally recognized artists with local artists in the small town of Antonito, Colorado (pop. 779).

The museum is located in an abandoned building that was previously the town drugstore. Rael San Fratello purchased the building, demolished the interior and completely transformed the space into a typical modern gallery interior. A director was installed during the summer of 2013 who curated bi-weekly performance pieces, a museum shop and gave tours. NOWHERE asks the question, "Can art be a seed for economic development in a small town?"

Nowhere sign by Golden West Sign Arts


Performance piece by Chloe Rossetti


Interior: installations by Ehren Toole, Elmgreen + Dragset, Future Farmers and Stephanie Syjuco among others


Local visitor examining ceramic cups by Ehren Toole

THE MUD HOUSE

Project Date: 2008
Project Team: Ronald Rael, Virginia San Fratello,
Jeremey Chinnis, Natalie Gambill

The Mud House is located in in the high West Texas desert in the town of Marfa, TX. The house is inspired by the landscape, traditional building practices and the contributions of Donald Judd and is situated in a landscape of ocotillo, mesquite, yucca and sotol with a view to the Davis Mountains in the distance.

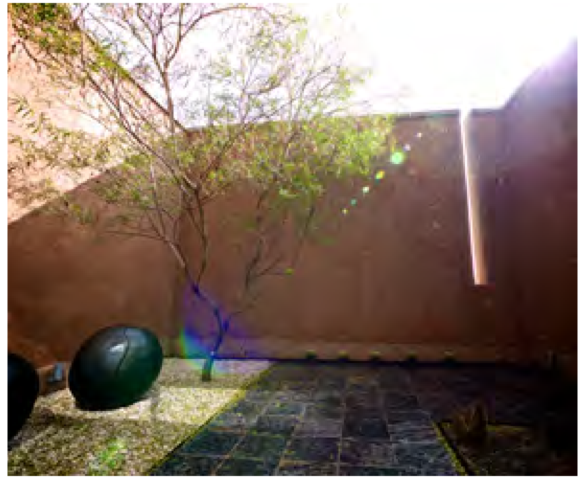
The Mud House is a large earthen box, designed to be easily constructed of mud brick and plastered with local soils mixed with cactus mucilage, horse manure and straw on the interior and exterior, and contains a smaller box inside that houses the major utilities of the housew.

Radiant heating in the floors warms the body in the cool winters and the massive earthen walls store the heat minimizing energy costs. The sun also enters the space in the winter months through a courtyard that connects the house to the sky and outdoors directly from the living area. The contrast between the thick, earthen walls and the concrete lintels that interpenetrate the façade to create openings, as well as the use of stainless steel in contrast with the earth, create a tension between old and new, rough and smooth, and the industrial and non-industrial.

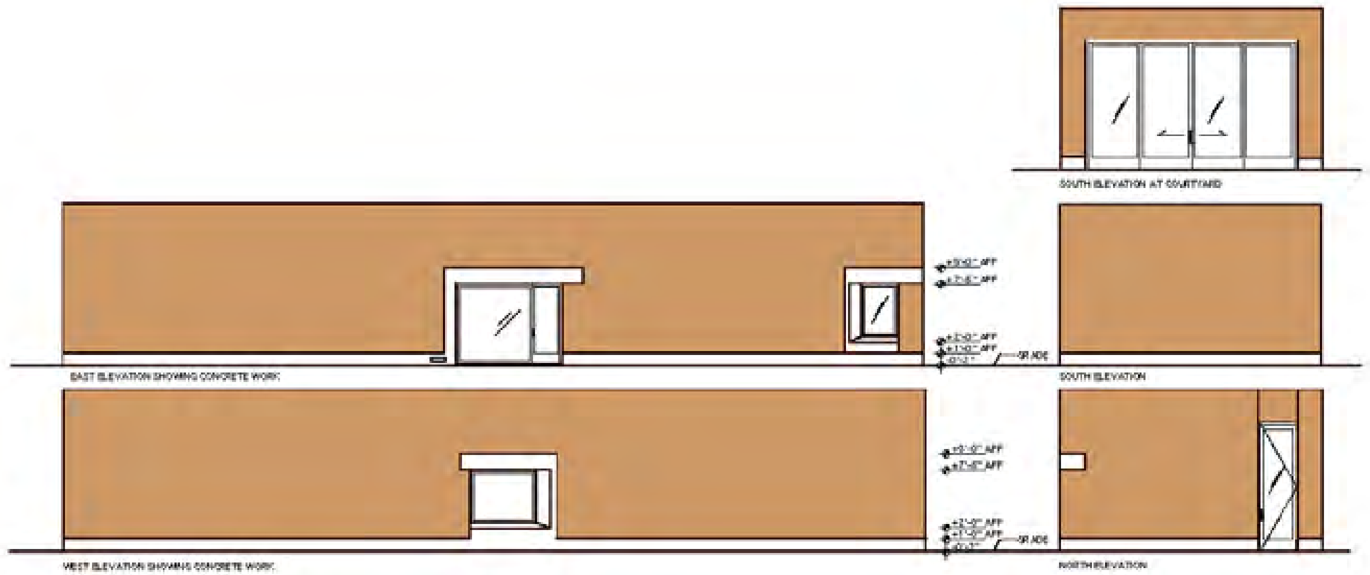
In the summer months, a subtle overhang over the courtyard entrance prevents direct sunlight from entering the house and the mud walls and high ceilings keep the interior cool. The clients, who are art lovers, selected works that are complimented by the earthen walls such as Kiki Smith and Susan York.

The entrance to the Mud House is through a slit in the earthen wall adjacent to a concrete pool that fills with water from the desert rains that is filled via the large scupper extending from the roof.

view of the big window



Inside, a large courtyard opens to the interior and to the sky, bringing in vast quantities of light, while shielding the desert sun.



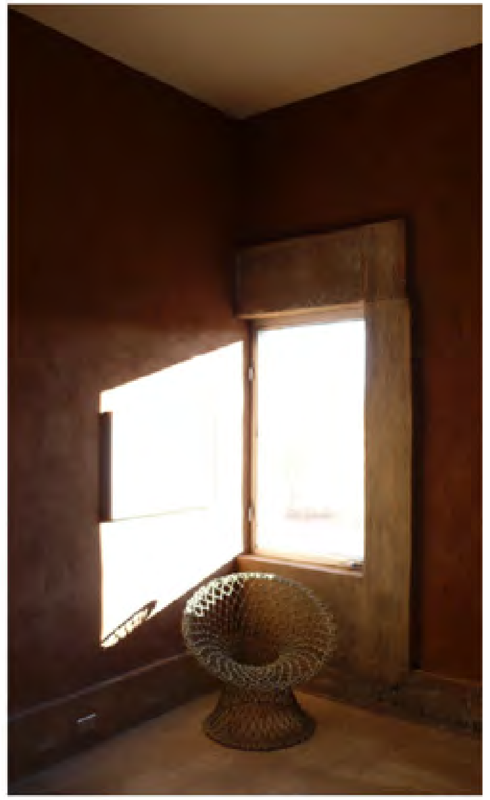

Donald Judd aluminum box


Interior perspective showing aluminum box and ceiling and changing reflections and light

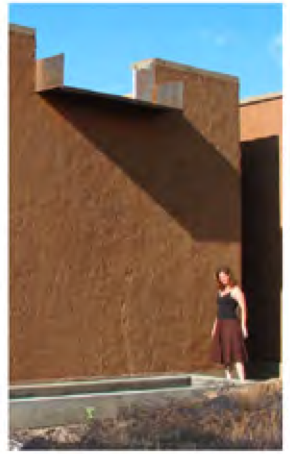

View of Haystack Mountain from big window

right: view of the mud plastered interior and big window

Two types of mud bricks, or adobes, were used in the construction. The lower portion has adobes made in New Mexico that posses a higher compressive strength and resistance to water. Towards the top of the wall, adobes made in nearby Ojinaga, Mexico were used that are lighter in both weight and color. The mud used in the plaster is from Van Horn and has a beautiful reddish tint.



this page: concrete lintel and window in the bedroom



right: north wall with scupper